ministry of
environment

A Fisher Management Strategy for British Columbia

Wildlife Bulletin No. B-63
November 1989

BC MINISTRY OF ENVIRONMENT

ISSN 0829-9560

A FISHER MANAGEMENT STRATEGY FOR BRITISH COLUMBIA

Vivian Banci

Prepared for:

B.C. Ministry of Environment
Wildlife Branch
Victoria, B.C.

Wildlife Bulletin No. B-63

November 1989

90-04124/

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Canadian Cataloguing in Publication Data
Banci, Vivian.

A fisher management strategy for British Columbia

(Wildlife bulletin, ISSN 0829-9560 ; no. B-63)

ISBN 0-7718-8913-5

1. Fisher (Animal) - Control - British Columbia.
I. British Columbia. Wildlife Branch. II. Title.
III. Series: Wildlife bulletin (British Columbia. Wildlife Branch) ; no. B-63.

QL737.C25B36 1989 639.9'7974447 C90-092051-3

OBJECTIVE

The objective of this report is to synthesize available information and outline an approach for the management of fishers (*Martes pennanti*) in British Columbia. This contribution is the third in a series for Class 2 species and follows management strategies for lynx[1] and wolverine[2]. Class 2 species are "those that move between and among traplines, are vulnerable to over-trapping and are generally not found in manageable numbers within a single registered trapline".

Comprehensive reviews of fisher biology are in Strickland *et al.* (1982*b*) and in Douglas and Strickland (1987). These publications are readily available and a third review is unnecessary. Although some duplication is inevitable, this effort differs in that the focus is on the management of fisher populations and their habitats. This document was written for wildlife management staff, for trappers, and for researchers. Practical aspects are emphasized and whenever applicable, technical considerations are presented, including a review of livetrapping and handling methods.

The report is in three parts, a review of the biology and management of fishers, an annotated bibliograpy, and a summary statement, intended for the trapper. The source of all information was the literature listed in the bibliography and conversations with management personnel, species specialists, and trappers. Common names are used for all species; scientific names may be found in the original reports.

ACKNOWLEDGEMENTS

I thank A.W. Allen (Department of Fish and Game, Colorado), S. Arthur (Maine Cooperative Wildlife Unit), R. Leonard (Parks Canada, Manitoba), and M. Strickland (Ministry of Natural Resources, Ontario) for providing literature and information. Information on the management of fishers in British Columbia was provided by R. Archibald (Ministry of Environment, Victoria). R. Powell and M. Strickland critically reviewed the manuscript.

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[1]Hatler, D.F. 1988. A lynx management strategy for British Columbia. Ministry of Environment, Wildlife Bulletin No. B-61. Victoria, B.C. 122pp.

[2]Hatler, D.F. 1989. A wolverine management strategy for British Columbia. Ministry of Environment, Wildlife Bulletin No. B-60. Victoria, B.C. 135pp.

PART 1: SUMMARY STATEMENT

The fisher belongs to the Mustelidae, the family that also includes wolverines, otters, weasels and martens. The fisher is closely related to the North American marten. Both species share the same genus, *Martes*. Fishers only occur in North America. British Columbia represents the northern limit of distribution of fishers although a few stray into the northeast corner of Yukon. Fishers do not occur in Alaska nor on the coastal islands.

Fishers are susceptible to overtrapping and habitat loss. During the late 1800's and 1920's, fisher pelts were worth up to $300 and demand was high. Overtrapping, habitat losses from settlement and logging, and the widespread use of poisons as a predator control agent and as a means of trapping caused population reductions in many areas. By the 1930's fishers were almost exterminated in the United States. Fortunately, fishers have the ability to rebound quickly. They have been reestablished in most of their former range by habitat improvement, control of harvests and trapping, and in some areas by transplants. North American harvests during the 1970's and 1980's are higher than they have ever been. However, compared to other species, such as the marten, harvests are small. This is because fishers occur at low densities, they are solitary, have small litters, and large home ranges compared to carnivores of similar size.

DESCRIPTION

Males are the larger sex, they weigh 3-5 kg, and females weigh 1-2 kg. Females have darker, silkier furs than do males and are worth more on the market. Small juvenile males have fur intermediate in quality between females and older males. There are no recognized subspecies of fisher, although eastern Canada appears to produce a better quality fur than western Canada. The presence of the large saggital crest on the top of the skull indicates an adult in males. In females, the presence of a saggital crest also indicates an adult, but not all adult females have saggital crests. The baculum, the penis bone of males, increases in weight and changes in shape with age. All females that are pregnant are adults.

REPRODUCTION

Like wolverine and marten, fishers have delayed implantation. Kits may be born from January to April but most births occur from March to April. The timing of implantation likely depends on food availability and on the condition of females. Litter sizes are small, ranging from 1-4, with 2-3 being average. Females go into heat 2-10 days after giving birth. Breeding generally occurs from late February to the middle of April. Females do not mate until their second spring and have their first litter at 2 years of age. Not all females within a population may be pregnant. Pregnancy rates in carcass samples have ranged from 73% to 100%. Studies on live fishers in Maine indicate that even if a female is pregnant, she may not have kits. Females have delayed implantation and may interrupt their pregnancies if they are not in sufficiently good condition during winter.

DIETS

Fishers eat a diversity of foods although snowshoe hare and porcupine are frequent prey. Other foods which have been documented in diets are carrion (deer or other ungulates), voles, mice, shrews, moles, muskrats, beaver, rabbit, raccoon, marten, birds (especially grouse and jays), snakes, fish, eggs, vegetation, nuts, apples, beechnuts, and fungi. The food groups snowshoe hare,

porcupine, deer, squirrels, small mammals, and birds can be considered the staples of the fisher diet. Smaller prey, such as mice and squirrels, are more important when large prey are unavailable. When a prey becomes more abundant, such as during an increase in the snowshoe hare cycle, fishers rely more on that prey type and use other prey less. In Manitoba, fishers frequently ate ducks, particularly during early winter when large migratory flocks frequented the area. Similarily, muskrats were common in shallow bays of lakes and were an important food. Apples were important in the winter diets of fishers in New Hampshire and Maine, because they were readily available in those habitats.

All species of squirrels and all species of small mammals are eaten, depending on what is common in the environment. Deer and moose are consumed as carrion. Fishers return to old kill sites during cold, stormy weather, when other food is unavailable. Returning carcasses to the trapline, especially during times of low food availability, will benefit fishers. Fishers in summer and fall eat a greater diversity of foods, including fruits and nuts. Few differences in diets occur between sexes although the smaller female may not be able to kill large porcupines, those more than 7 kg in weight.

The fisher-porcupine relationship has been documented frequently and fishers have been transplanted into areas for porcupine control. Fishers hunt porcupine in open, upland, hardwood forests, travelling in long distance (up to 5 km), straight line movements directed to porcupine dens. They kill porcupine by repeated attacks to the unquilled face, a method apparently unique to this species. For all other prey, the hunting behaviour of fishers is characterized by frequent changes in direction and zig-zags. They hunt prey near and in overturned tree roots, downed logs and brush piles.

Most of the prey of fishers display population "highs" and "lows". Populations of mice and voles commonly fluctuate every 3-4 years and hares and grouse have a 9-10 year cycle. Fishers are affected by the periodic abundances of prey, however, trends in population size are not predictable.

MORTALITY

Fishers appear to have few enemies besides humans. Although many parasites have been documented in and on fishers, few have ill effects. Sarcoptic mange, a contagious skin disease caused by a mite, has been found on fishers. These mites damage the pelt and may be a serious mortality factor, if infestations are heavy. Fishers are frequently pierced by porcupine quills. Quills carry no poisons or irritants and have no characteristics that could cause infections but the occasional injury does occur.

HABITAT

Habitat studies indicate that fishers frequent ecotones and edges, the transition areas between different types of habitats, and riparian areas, those that are associated with rivers and streams. Fishers are not as dependent on climax coniferous forests as are marten. Generally, they occur at the middle range of elevations and changes in elevation between seasons do not occur. Deep snow hinders the movements of fishers and affects their use of habitats in winter. Fishers active on soft snow may use 54% more energy per day than fishers on hard snow. Because of their larger size, fishers are affected to a greater extent than are marten. The effects of snow cover may be important in understanding why marten occur in habitats where fishers are absent. The lack of fishers in coastal habitats is likely because of the deep, wet snow in these areas.

Dens used as resting sites by fishers are diverse and include snow dens, hollow logs, holes in the ground, witches brooms, squirrel nests, and raptor nests. Natal dens, however, almost exclusively occur in cavities in large dead trees, located 7-12 m above the ground. Tree cavities provide thermal protection for kits, protection from adult male fishers, and security from predators. A secure den is especially important considering a female may leave her kits unattended for long periods.

Reserves of unlogged and untrapped wilderness have been important in the reestablishment of fisher populations. Such reserves not only provide a source of dispersing fishers for trapped regions but are insurance against population reductions. Trappers may be able to maintain adequately sized reserves on their traplines but the size of this area will depend on habitat quality.

HOME RANGE SIZE AND MOVEMENTS

Home ranges of adult males are 20-34 km² in size, and for adult females, 15-19 km². Males have larger home ranges and their movements are greater than for females. The spatial system of fishers appears to be similar to that of other mustelids, where the range of 1 male overlaps ranges of more than 1 female but home ranges within sexes do not overlap. Female home ranges change little in size throughout the year. Adult males abandon their home ranges during the breeding season, February to April, in search of females in heat. They are very susceptible to being trapped at this time. The movements of juveniles during dispersal may be extensive. Fishers may travel long distances, movements of 13-16 km in 1 day and 97 km in 3 days have been documented.

HARVESTS

A female bias, specifically in adults, appears to be common in fisher harvests. Because males are more vulnerable due to their greater movements and larger home ranges, more of them are expected to occur in harvests. When populations are lightly trapped, more males do occur in the harvests. When populations are being trapped intensively, however, more females are trapped. This likely means that there are more females in the population. This is a problem if there are too few males available to impregnate all the females. When fisher populations in Ontario were trapped heavily, barren females began to appear in the harvests. After the trapping season was truncated to the end of December and quotas were reduced, all females in harvests were pregnant.

Why females outnumber males in fisher populations is not clear. Males in harvests are typically not older than 4-5 years, while females may reach 11 years in age. The sex bias in Ontario harvests was not evident until males were 2-years-old, implying that juvenile males had a high mortality. Pelt scarring was also more frequent in males, and most frequent in juveniles. Juveniles may be attacked by adult males, likely during the breeding season. Adult females have the lowest mortality of all age groups. Females outnumber males probably because of their lower mortality and a higher mortality of males.

DENSITIES

Densities estimated for regions in eastern North America are relatively high, ranging from 1 fisher/0.6 km² to 1/18.9 km². The estimates from western regions, British Columbia and California, are >1/200 km². Densities in the west are likely lower than in the east but considering that home ranges are

less than 100 km² in size, these estimated densities are too low. Information is insufficient to estimate densities and population sizes of fishers in British Columbia.

FISHER AND MARTEN

It has been suggested that competition between fishers and marten may be an important factor controlling distributions and population levels. Fishers and marten often do not occur in the same area and the two species appear to use different kinds of habitats. Fishers occupy lower elevations and are better adapted to earlier successional stages of forests than are marten. Marten are smaller and are more arboreal, they are better able to hunt under the snow during winter, and they are less restricted by snow cover than fishers. The requirements for suitable resting sites in winter by marten may be more specific than for fishers as marten are not efficient at retaining body heat.

MANAGEMENT

The numbers of fishers present on a trapline depends on habitat quality, reproduction, and the habitat quality of surrounding traplines. Fishers prefer diversity in habitat, thus riparian areas, ridgelines, and small forest openings will contribute to habitat quality. One researcher suggested that promoting the growth of alders for beavers would also benefit fishers. Because fishers are also scavengers, the return of carcasses to the trapline will increase habitat quality and may draw in fishers that are dispersing from surrounding or untrapped areas. Because reproduction is tied to food availability, supplementing the trapline with food, especially during shortages, will benefit pregnant females.

The objective in trapline management for fishers is to leave a breeding population and trap dispersing juveniles. Because home ranges are relatively large, this cannot be accomplished by simply staggering trap placement. Large, untrapped areas will maintain a reserve population and provide insurance against population reductions. The size of reserve which is adequate depends on habitat quality and not all traplines may have sufficient habitat to maintain such areas.

Females appear to outnumber males in the population. Thus, if harvests have a large number of males, the population is being trapped lightly. A greater proportion of females means that harvesting is heavy. Because pockets of females may occur, the harvest of one trapper is not necessarily indicative of the entire population. To be useful to the trapper, these harvests need to be combined and presented on a regional basis.

Because of breeding movements, males are more vulnerable to trapping during late winter and early spring. Overtrapping males may result in barren females, thus it is best to trap earlier in the season (before January). Additional benefits of trapping early are that a greater proportion of non-breeders, or juveniles will be trapped and pelts reach peak primeness earlier. Fishers are easily trapped and a proportion may be caught in traps set for other species. A trapper attempting to limit his fisher harvest should avoid placing traps where fisher tracks are present.

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PART 2 : SPECIES BIOLOGY AND MANAGEMENT OF FISHER

2.1 INTRODUCTION

2.1.1 The Fisher in North America

The genus *Martes* is holarctic but fishers (Carnivora, Mustelidae) are unique to North America. The species occupies the broad band of Boreal Forest that traverses northcentral North America. It also occurs in the Northeastern Mixed Forest, the Pacific Coastal Forest, and the Coniferous Forest vegetation zones of Allen (1987). Seton (1926) described the distribution of fishers as extending from Nova Scotia to Latitude 62° on the Mackenzie River, near Great Slave Lake, west to the Pacific Ocean, with 3 arms extending southward, the first to South Carolina on the east coast, the second to Wyoming, the third to central California, and a fourth arm on the Pacific extending northward to the interior of British Columbia. British Columbia represents the northern limit of distribution of fishers. A few occasionally stray into the northeast corner of Yukon (Youngman 1975). Fishers do not occur in Alaska nor on coastal islands. Their present distribution is reduced from their range before settlement on the continent by Europeans but most of this reduction has occurred in the United States (Powell 1982).

Historical fur harvests (Obbard *et al.* 1987) demonstrate that a large decline in populations and a reduction in distribution occurred early in this century. Records from the 1700's to the 1750's are incomplete but indicate that, generally, yearly harvests were less than 1000. More complete harvest records were available after the 1760's. North American harvests of fishers peaked in the 1790's and 1840's, at yearly averages of about 11 000 pelts. Fisher pelt prices peaked in 1920; the average value was $85 and the maximum $300 (Brander and Books 1973). These were large sums for trappers in the early 1900's and the demand for fisher pelts was high.

Harvests declined to an yearly average of 5500 pelts during the 1920's and to 3300 pelts per year in the 1940's, the lowest average for any decade (Obbard *et al.* 1987). The decrease in harvests was a direct reflection of population reductions due to habitat losses from settlement and logging, overtrapping, and the widespread use of poisons as a predator control agent and as a means of trapping (Anderson 1934; Brander and Books 1973; Douglas and Strickland 1987). By the 1930's, fishers were almost exterminated in the United States, except for small populations in Maine, the White Mountains (New Hampshire), the Adirondack Mountains (New York), northeast Minnesota, and California (Brander and Books 1973). By 1940, fishers were extinct in Nova Scotia (Benson 1959). Concerns prompted closure of trapping seasons, 1922 in Wisconsin, 1929 in Minnesota, 1935 in New Hampshire, 1936 in New York and Wyoming, 1937 in Maine and Oregon, and 1946 in California (Brander and Books 1973). Seasons were rarely closed in Canada but the registration of traplines helped to control harvests. By the 1950's, the demand changed from fishers to spotted cats and fisher prices dropped to $10-$15 per pelt (Brander and Books 1973).

North American harvests during the 1970's and 1980's are higher than the peak harvests of the 1790's and 1840's. These increases are attributable to a success in management. Fishers have been reestablished by habitat improvement, legislative control of harvests and trapping, and in some areas, by transplants. Canadian harvests dominate the market, providing from 68% of all pelts sold in the 1970's, to 100% in the 1940's. With fishers reclaiming their former range, American harvests, beginning in the 1960's, have increased. In the 1980's, more than 21 000 pelts are sold

yearly (Obbard *et al.* 1987). These harvests are large for fishers, but low relative to harvests of other species. Since the 1950's, the only species in North America with lower harvests have been brown bear, polar bear, mountain lion, wolf, and wolverine. Small harvests are attributable to low densities, a function of the species' solitary lifestyle, and home ranges that are large compared to carnivores of similar size.

2.1.2 The Fisher in British Columbia

Recent (1984/85 to 1987/88) harvests of fishers in British Columbia are relatively small and only exceed harvests of wolverine, wolf, and bobcat. In average pelt value, however, the fisher rates third to fourth (but fifth to ninth in total value). Fluctuations are characteristic of the British Columbian harvest (Fig. 1). The peak harvest during 1919-20 to 1987-88 was 1747, in 1973-74, and the peak average pelt value was $280, during 1986-87. Currently, harvests are decreasing, from 941 pelts sold in 1982-83, to 325 in 1987-88. Average pelt values, however, are increasing (Fig 1); corresponding to a general increase in prices for all furbearers. Because fluctuations are a characteristic of the fisher harvest, and because harvest trends are not necessarily equivalent to trends in population size, conclusions regarding population status are inappropriate.

Trapping seasons in British Columbia occur within November to February (Table 1). Seasons were originally set to coincide with times of greatest pelt primeness (Obbard *et al.* 1987). In most

Table 1. Open seasons for fishers within British Columbia administrative regions.[a]

	Region	Trapping season
2.	Lower Mainland	15 Nov - 15 Feb
3.	Thompson-Nicola	1 Nov - 15 Feb
4.	Kootenay	no open season
5.	Cariboo	15 Nov - 15 Feb
6.	Skeena (6-3,-11,-14)[b]	15 Nov - 15 Feb
	(other m.u.)	1 Nov - 28 Feb
7.	Omineca-Peace	1 Nov - 28 Feb
8.	Okanagan	1 Nov - 15 Feb

[a] 1989-1990 British Columbia Hunting and Trapping Regulations Synopsis.

[b] management units (m.u.).

administrative regions of British Columbia, trapping seasons for fishers are the same as a number of other furbearers and differences in seasons likely reflect changes instituted for martens (R. Archibald, pers. comm.). During 1983-1987, Regions 5 (Cariboo) and 7 (Omineca-Peace) have provided most of the fisher harvest in British Columbia (Fig. 2). The number of fishers harvested cannot be used as an index to productivity without estimates of trapping effort and the size of area trapped. Locations of harvests, however, may indicate distribution patterns and habitat productivity. Generally, fishers have not been harvested from coastal management units and from northwestern management units (Fig. 3).

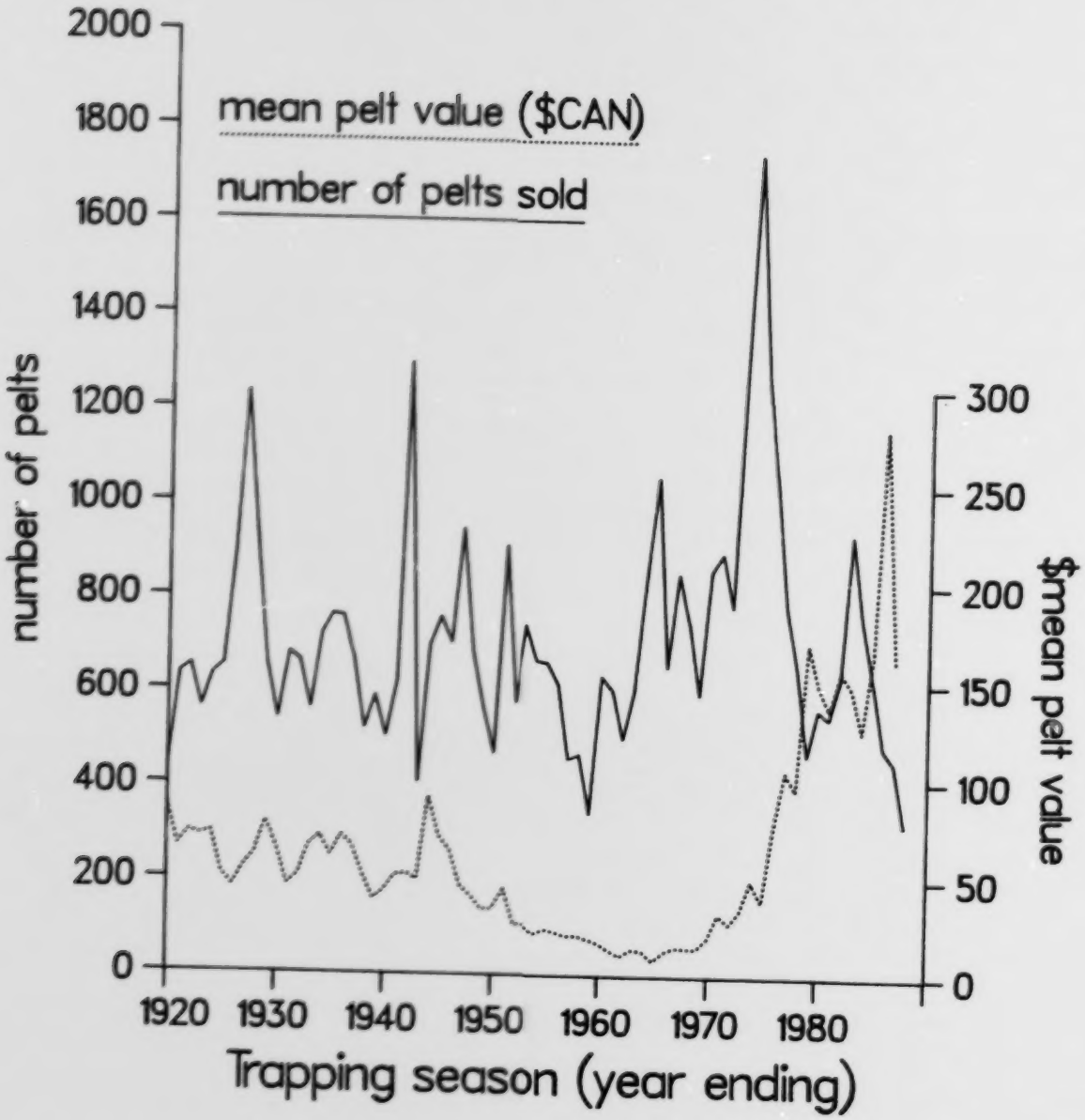

Figure 1. Numbers of British Columbia fisher pelts sold and their average value from 1919-20 to 1987-88.

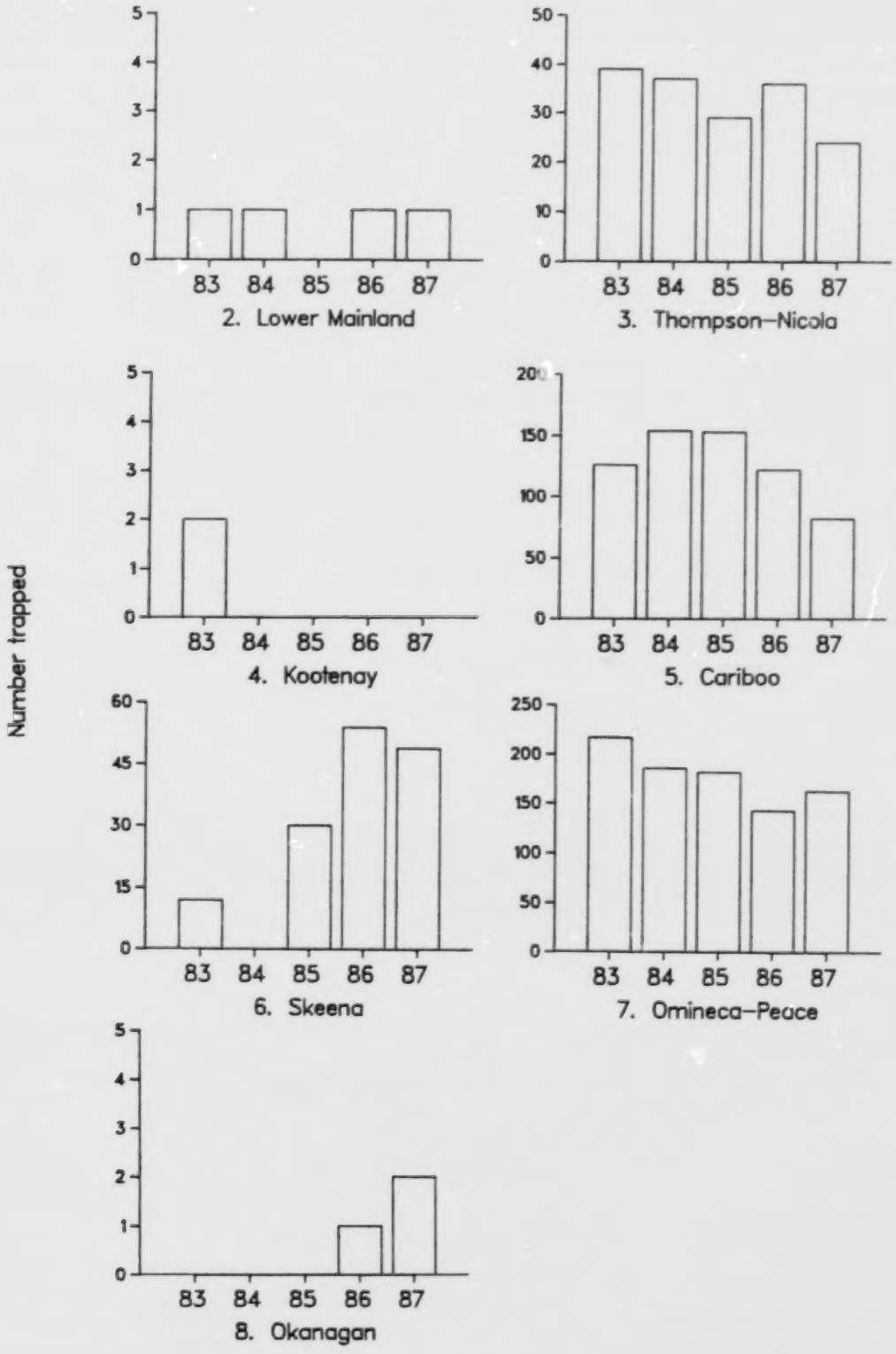

Figure 2. Numbers of fishers harvested from administrative regions of British Columbia from 1983-84 to 1987-88.

Figure 3. Distribution of fisher harvests (1983-84 to 1987-88) within administrative regions of British Columbia.

2.2 DESCRIPTION

2.2.1 Features

The Fisher Pelt.-- Females have darker, silkier furs than do males (Obbard 1987). The pelt value for females is greater than that for large adult males, which have coarse fur. Small juvenile males have fur intermediate in quality between females and adult males (Obbard 1987). Fur buyers consider that the finest furs of fishers are produced in Ontario, Quebec, and the northeastern United States (Obbard 1987). Eastern pelts are fine and silky, and they have denser and bluer underfur than pelts from other regions. Western pelts are generally coarser in texture and paler (Obbard 1987).

Primeness is defined as "when the fur has reached its maximum length, density, and finest texture, when the hairs have matured with seemingly no pigment being produced, and as a consequence, the flesh surface of the pelt appears devoid of hair root pigmentation" (Linde 1963 *in* Worthy *et al.* 1987). This period of primeness can be determined from physiological characteristics (Worthy *et al.* 1987). Stains (1979) indicated that primeness of fisher pelts peaked in January but that the peak period also included December. Powell (1985) reported that primeness peaked in late November or December. These reports are not necessarily contradictive. Peak colour is often attained shortly before prime condition is reached, and such pelts may be worth more than a fully prime pelt (Worthy *et al.* 1987). Dates of primeness may vary and depend on latitude; northern pelts are prime before southern pelts (Worthy *et al.* 1987).

Weights and Measurements.-- Fishers are the most sexually dimorphic of all the mustelids (Table 2). The range between weights of sexes may be almost six-fold. The largest documented weight was 11.5 kg for an adult male (Blanchard 1964). Age classes also differ in mean lengths (Table 3), however overlap precludes using this measurement to age fishers.

Table 2. Ranges of mean weights (kg) for age and sex classes of fishers (Wright and Coulter 1957; Brown 1965; Coulter 1966; Kuehn 1985; Douglas and Strickland 1987).

	Juvenile (<12 mos.)	Adult (>18 mos.)
Male	3.2 - 3.8	3.8 - 4.9
Female	1.7 - 2.4	1.8 - 2.4

Table 3. Average body lengths (mm) for age classes of fishers in Ontario (Douglas and Strickland 1987).

	Juvenile (*n*)	Adult (*n*)
Male	59.7 (1282)	62.2 (472)
Female	50.8 (1091)	51.4 (606)

Often, estimates of whole weights are desired but only skinned weights are available. Kuehn (1985) reported a ratio of skinned : live weights of 77.5 for males and 81.1 for females in Minnesota. In Maine, ratios for females were also higher than those of males (Wright and Coulter 1957). Only Kelly (1977) reported the reverse, a greater skinned : whole weight ratio for males.
A higher ratio for females is consistent with the relationship expected from allometry, larger males should lose proportionately more weight after skinning.

Skeleton and Musculature.-- The skeleton of the fisher "resembles that of the domestic cat" but has more developed forelimb skeletal elements (Leach 1977*b*). This may confer an enhanced digging ability (Leach 1977*b*). Although the use of burrows as resting sites has been documented (Section 2.3.3.3), reports of digging by fishers have not. The forelimb musculature in fishers is strongly developed, indicating its importance in cursorial locomotion (Leach 1977*a*). Fishers can rotate their hindlimbs to permit a head first descent of trees (Coulter 1966), a factor which facilitates arboreal activity (Douglas and Strickland 1987). However, reports of the arboreal activity of fishers apparently have been exaggerated (deVos 1951; Coulter 1966; Powell 1980*b*; Raine 1981). Any enhanced ability of the forelimb for arboreal locomotion is likely a secondary function (Leach 1977*a*).

2.2.2. Systematics

Evolution.-- Anderson (1970) described the Quaternary evolution of martens and fishers. The genus *Martes* occurs in 3 subgenera, *Martes*, *Pekania*, and *Charronia*. *Martes pennanti* is the sole representative of the subgenus *Pekania*. It differs from the true martens by its large size and an external median rootlet on P^4 (absent in the subgenera *Martes* and *Charronia*). Fishers can be traced back to the middle Pleistocene from *M. diluviana* (the first true fisher in North America), and from the Chinese Pontian form, *M. palaeosinensis*. The modern fisher is known from the late Pleistocene and postglacial deposits in the United States. The earliest known occurrence is from the late Wisconsin but fishers may have come across from China in late Illinoisan or early Wisconsin times. *M. pennanti* probably did not directly descend from the historical *M. diluviana*, which is only known from middle Pleistocene remains. No fossil fishers between the two species have been dated. *M. diluviana* likely was the fisher's ecological forerunner. The distribution of fossil sites indicated that fishers once lived in areas further south than occupied in recent times.

Taxonomy.-- The scientific name *Martes pennanti* was given to the fisher in 1776 by Johann Erxleben in honour of the Welsh naturalist Thomas Pennant (1726-1798) (Douglas and Strickland

1987). Three subspecies have been designated. *M. pennanti pennanti* is the eastern variety identified by Erxleben in 1777 (Peterson 1966), and said to occur no further west than the Manitoba-Ontario border (Goldman 1935). Rhoads (1898) designated the West Coast subspecies *M. pennanti pacifica* using an "inferior series of skins and skulls" (5 skulls, 2 skins). He characterized it as having a large size, in body and in skull, and with some colour differences. Distribution is the Pacific slope from Alaska to California (Rhoads 1898). *M. pennanti columbiana*, the British Columbian fisher, was designated by Goldman (1935) from 95 specimens. Distribution is the Rocky Mountain Region, from northern British Columbia, south to central Idaho and east to southern Canada, grading to *M. pennanti* in Manitoba (Goldman 1935).

Further analyses have not supported any of these subspecific designations. Grinnell *et al.* (1937) documented large variation in the pelt colour of *M. pennanti pacifica* and suggested that the extensive wandering of fishers promoted crossbreeding. Hagmeier (1959) reexamined all 3 subspecies using 321 skulls. He noted that geographic variation was slight and that the subspecies were "lightly characterized". Anderson (1970) examined skulls, teeth, and postcranial skeletons of 1941 fossil and recent fishers in east and west populations and concluded that subspecific designations were unwarranted.

Age Determination.-- Changes in the fisher skull that occur with increasing age, are primarily an increase in zygomatic breadth and a decrease in the postorbital constriction (Grinnell *et al.* 1937; Anderson 1970). Using these 2 characteristics, 4 age/sex classes (adult male, adult female, young male, young female) can usually be distinguished, although there is some overlap (Anderson 1970). Coulter (1966) and Wright and Coulter (1967) reported that the only skull measurement suitable for distinguishing juveniles from adults was the length of the saggital crest in females, and the length of the overhang of the saggital crest beyond the supraoccipitals in males. The saggital crest in the male increases noticeably in height and length with age (Wright and Coulter 1967; Anderson 1970; Douglas and Strickland 1987). In females, a saggital crest indicates an adult, but not all adult females have saggital crests (Douglas and Strickland 1987).

Researchers have attempted to age fishers using a variety of characteristics (Table 4), but the lack of known age material has been a major obstacle in verification. Kelly (1977) was one of the first researchers to attempt to age fishers using cementum analysis. Strickland *et al.* (1982*a*) presented the first correspondence of annuli in dental cementum with the known ages of 8 fishers. The first annulus (mainly premolars were used) usually appears in June, at 15 months. After that, from July through March, the number of bands corresponds exactly with the age in years (Strickland *et al.* 1982*a*). Thus, ages of fishers trapped in winter are designated as 0.5 years, 1.5 years, 2.5 years, and so on.

The pulp cavity in the canine of juveniles is relatively large in diameter and decreases in size with the deposition of dentine as the mammal ages. Kuehn and Berg (1981) used radiographs of the lower canines to distinguish adults from juveniles, and verified their results with cementum analysis. Within the December to January period, the use of radiographs was a relatively quick and inexpensive method of aging fishers (Kuehn and Berg 1981). Jenks *et al.* (1984) used measurements of the canine and pulp cavity to age fishers to a maximum of 3.5 years. Dix and Strickland (1986) questioned the accuracy of their predictions and the calculation of population confidence limits. They suggested that only 2 age classes, 0.5 and ≥1.5 years, could be distinguished with confidence.

Table 4. Age determination in fishers. (Most specimens were collected during the trapping season and any determination of age must consider the time of year.)

Feature	Age classes distinguished	Authors
zygomatic-temporal, naso-maxillary, & naso-frontal sutures	Juv. - open Ad. - closed	Wright and Coulter 1967
overhang of the saggital crest	Males Ad.- Juv. <6.0 mm - Juv.	Wright and Coulter 1967
bacula weights (before Feb.)	>1000 g - Ad. <1000 g - Juv.	Wright and Coulter 1967
fusion of distal femoral epiphysis (using radiography)	not useful	Dagg *et al.* 1975
cementum analysis*		Liskop *et al.* 1980
radiographs of canine pulp cavity	Ad. - Juv. (Dec - Jan)	Kuehn and Berg 1981
development of the suprafabellar tubercle in femur	Ad. - Juv. males (not for females)	Leach *et al.* 1982

* a photographic technique for enhancing cementum lines in sections of canine teeth.

Sex Determination.-- The skull measurements of zygomatic width, skull length, and skull weight (in cleaned skulls) may be used to distinguish sexes (Douglas and Strickland 1987). The best skull characteristic for sex discrimination is the large saggital crest of males (Douglas and Strickland 1987). Complete separation occurs in all humerus, radius, ulna, tibia, and fibula measurements (Leach 1977*b*), but overlap precludes using femur measurements for sex discrimination (Leach and Dagg 1976). Leach and de Kleer (1978) described sex differences in some skeletal elements.

Parsons *et al.* (1978) used the dimensions of the root of the lower canine to successfully sex New York fishers. With a maximum root width of 5.6 mm, all males (n = 98) were identified correctly, and 148 of 149 females. A maximum root thickness of 4.0 mm correctly sexed 147 of the 149 females and 94 of the 98 males. Thus, both sex and age ratios (Kuehn and Berg 1981, Table 4) in a harvest can be determined if the lower canine is available. Because of overlap, pelt size is not a reliable criterion for determining sex and age classes (Douglas and Strickland 1987). However, sex may be determined accurately because the presence of a preputial orifice is definitive for males (Douglas and Strickland 1987).

2.2.3. Distribution and population status

Western North America.-- Distributions of fishers in the eastern and central United States are summarized in the bibliography. Most fishers in Canada are harvested from Ontario and Quebec (Rand 1944). Rand (1944) stated that fishers were harvested from 90% of British Columbia and Hagmeier (1957) cited them as being "common" in the province. In terms of area, but not necessarily productivity, British Columbia has more fisher range than any other province. In the last decade (1969 to 1979) British Columbia has rated fourth or fifth in fisher production, behind Alberta, Ontario, Manitoba and Quebec (Strickland and Douglas 1981). During 1976-77 and 1978-79 British Columbia rated sixth, behind Saskatchewan (Strickland and Douglas 1981).

MacLeod (1950) described distributions of fishers in the Coast Forest, Edwards (1950) and Edwards and Cowan (1957) in the Boreal Forest, and Bandy (1952) in the Columbia and Dry Forests (eastern British Columbia). In all studies, productivity was determined from harvests and calculated as the average area required to produce 1 pelt in 1 year. Although their results do not indicate actual productivity of habitats, they provide a relative assessment of habitat quality (Table 5). I have changed original habitat descriptions to correspond with the ecosystem classification for British Columbia[1].

Edwards (1950) indicated that the centre of abundance for fishers in the Sub-boreal Interior was a slash of habitat extending northwest to southeast across the ecoprovince. Fishers were not harvested from southeastern British Columbia. Quick's (1953) designation of the Fort Nelson region (forest type 4 in Edwards 1950) as an area of fisher abundance was not supported by harvest records (Edwards 1950). Fishers were designated as rare in the Coast and Mountains ecoprovince (MacLeod 1950). MacLeod (1950) suggested that the high productivity determined for the Nass Basin and Nass Ranges ecoregions (Table 5) was an error. Current harvests indicate fishers are not trapped in this area (Fig. 3).

Fishers generally do well in the northeastern United States but occur in low numbers in all 3 western states (Bailey 1936; Scheffer 1938; Ingles 1965; Ingram 1973). In Washington, they are confined to the Cascade and Olympic Mountains (Scheffer 1938; Dalquest 1948). In Oregon, fishers occur in the cool humid Coast ranges and coniferous coastal forests (Bailey 1936). Fishers in California are most closely associated with mixed conifer and Douglas-fir cover types (Schempf and White 1977).

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[1]Demarchi, D.A. 1988. Ecoregions of British Columbia (map). Ministry of Environment, Victoria.

Table 5. Distributions of fisher harvests and productivities of habitats within British Columbia. Described forest regions in original reports were categorized according to British Columbia's biophysical classification[a]. Productivity is defined as the average area required to produce 1 pelt in 1 year (references cited below).

Ecoprovince [a]	Ecoregion [a]	Ecosection [a]	Productivity (1 pelt/km^2)
North Boreal Mountains [b]	Tatshenshini Basin		absent
North Boreal Mountains [b]	Northern Mountains & Plateaus	Teslin, Stikine, Tahltan Highlands	absent
North Boreal Mountains [b]	Northern Mountains & Plateaus, Liard Basin	North Cassiar Ranges	1/676
Taiga Plains, (northern) Boreal Plains [b]			1/1726
(central) Boreal Plains [b]			1/1170
Sub-boreal Interior [b]	Central Rocky Mountains	Hart Foothills	1/858
Sub-boreal Interior [b]	Central Rocky Mountains (average value)	Hart Ranges	1/455
Sub-boreal Interior [c]			1/2765
Southern Interior [c]			absent
Southern Interior Mountains [c]			absent
Coast & Mountains [d]	Pacific and Cascade		absent
Coast & Mountains [d]	Nass Basin, Nass Ranges		1/394 [e]
Coast & Mountains [d]	Coastal Gap		1/1797

[a] Demarchi, D.A. 1988. Ecoregions of British Columbia (map), Ministry of Environment, Victoria.
[b] Edwards 1950; Edwards and Cowan 1957 [c] Bandy 1952 [d] MacLeod 1950 [e] fishers likely trapped elsewhere ([d]).

2.3. LIFE HISTORY AND BEHAVIOUR

2.3.1. Reproduction

Females.-- Much of our knowledge of reproduction of fishers originated from captive animals. From observations on British Columbia fur farms, Hall (1942) presented the first evidence that the gestation length in fishers was almost a year long. Enders and Pearson (1943) described blastocysts in fishers and confirmed the presence of delayed implantation. The length of active gestation is between 30-35 days (Hall 1942; Coulter 1966). Hamilton and Cook (1935) first recovered blastosysts by syringing uteri with water, however, recovery rates are typically low because carcasses are usually in various stages of desiccation and decay (Coulter 1966, Douglas and Strickland 1987).

The range of parturition dates indicate variability in the timing of implantation, from December to March. The earliest potential date of parturition in Maine was for a female trapped in mid-January that had 3 well developed embryos (Coulter 1966). Three fishers trapped from 15 to 28 December in Ontario had well developed fetuses that would have been born before 15 January (Douglas and Strickland 1987). However, trappers may have provided incorrect dates of capture. In the same area (but a different year), a female trapped on 9 March had unimplanted blastocysts (Douglas and Strickland 1987). Parturition occurred during March and April on Ontario (Hodgson 1937) and British Columbia (Hall 1942) fur farms. For wild females in California, the estimated date of parturition was May (Grinnell *et al.* 1937; Allen 1942) and for females in Maine, parturition was estimated to occur in March, with a range of mid-February to 1 April (Wright and Coulter 1967). Wild females whelped litters on 29 or 30 March in Michigan (Powell 1977), and 28 March and in early April in Manitoba (Leonard 1986). A female trapped on 13 March in New York had embryos with crown-rump lengths of 75 mm (Hamilton and Cook 1955), indicating she was near term. The extremes in dates of implantation likely depend on local conditions such as food abundance and on the condition of females.

Litter sizes are small, usually ranging from 1-4, with 2-3 being the norm (Table 6). In one of the few estimates available for wild litters, females in Maine during 1988 raised 2 litters of 1, 1 litter of 2, and 1 litter of 3 (S. Arthur, pers. comm.). Estrus occurs from 2-3 (Laberee 1941) to 3-9 days (Hodgson 1937) after parturition. Dates of breeding on fur farms were 26 March - 23 April in Ontario (Hodgson 1937) and 5 April - 27 April in British Columbia (Hall 1942). Estimated dates of estrus for wild fishers in Maine were late February to mid-April (Coulter 1966), and late March to early April in Ontario (Douglas and Strickland 1987). A captive female in Manitoba appeared to be in heat on 8 April, 11 days after giving birth (Leonard 1986). Hodgson (1937) reported that a female not bred the first estrus may have a second heat in 2-3 days. Douglas and Strickland (1987) observed a female in September displaying characteristics of estrus. However, her behaviour may have been atypical because she was a captive and had never been bred (Douglas and Strickland 1987). Most information on reproduction is collected from carcasses, and thus is limited to the trapping season, usually a short period during early winter. Little is known about reproduction outside this period.

Table 6. Sizes of captive, wild and *in utero* fisher litters.

Litter size $\bar{x} \pm$ sd	Range	n [a]	Type [b]	Location	Source
3.0	3	2	C	Maine	Coulter 1966
3.4 ± 0.52	3-4	11	I	"	"
3.09		45	I	Ontario	Douglas and Strickland 1987
3	1-3	R	W	Vermont	Fuller 1979 [c]
		1	W	California	Grinnell *et al.* 1937
2.7 ± 0.72	2-4	R	W	"	"
	1-4	21	C		Hall 1942
2.5	1-4	R	W		Hamilton 1957
	2-3	2	C	New York	Hamilton and Cook 1955
	1-3	R	W		Kebbe 1961
4 [d]		1	W	Manitoba	Leonard 1980
3.0		3	I	"	"
2	2	1	W	Michigan	Powell 1977
3.3	3-4	9	I	Maine	Wright and Coulter 1967

[a] R - only the range was provided.
[b] C - captive, W- wild, I - *in utero*.
[c] *in* Douglas and Strickland 1979.
[d] The presence of 2 young was confirmed; 4 were suspected.

a. Natality.-- Estimates of productivity are often determined from corpora lutea counts. The number of corpora lutea in ovaries is an exact count of the number of eggs released. Douglas and Strickland (1987) found a loss of about 13% (of 45) between corpora lutea counts and fetuses. Wright and Coulter (1967) found complete agreement for 9 females. Productivities may differ among regions (Table 7) but sample sizes were too small to permit comparisons. Consecutive corpora lutea counts for 3 years in New Hampshire (G. Parsons *in* Douglas and Strickland 1979, Table 7) suggest that productivities may differ among years. However, in Ontario, no evidence of between-year differences were apparent in 12 years of data (M. Strickland, pers. comm.).

All reproductive studies have confirmed that females do not mate until their second spring and have their first litter at 2 years of age (Coulter 1966; Wright and Coulter 1967; Leonard 1986; Douglas and Strickland 1987). Ovaries of juveniles killed during winter in Manitoba contained small developing follicles (Leonard 1980). Two juvenile females killed on 1 and 8 March had ovaries with large follicles and their tracts were enlarged, indicating the onset of ovulation (Leonard 1980). Douglas and Strickland (1979, 1987) in Ontario have provided the most extensive information on age-specific natality of fishers. Productivity of Ontario females peaked at approximately 5.5 years of age (Fig. 4). The shape of the natality curve (Fig. 4) is consistent with the inverted U observed for most mammals (Caughley 1977: 83). Although sample sizes were small, natality appears to be lower for older females (Fig. 4). Productivity of young females in Maine (1.5-2.5 years, Shea *et al.* 1985, Table 8) may be lower than for females in Ontario, although results for older females were similar. Placental scars do not persist (Strickland and Douglas 1987), and when available, numbers are usually less than the number of fetuses. Coulter (1966) counted 2.93 ± 0.78 (n = 27) placental scars and 3.45 ± 0.52 (n = 11) fetuses.

b. Pregnancy rates.-- Barren females may occur within sexually mature age classes. Pregnancy rates were 85 - 95% for fishers in New York (G. Parsons *in* Douglas and Strickland 1979), 86 - 95% in Maine (Shea *et al.* 1985), 73% in Nova Scotia (N. van Nostrand *in* Douglas and Strickland 1979), and 81% in Manitoba (Leonard 1986). In northwestern British Columbia, 9 females aged 4.5 - 9.5 years were barren (Liskop *et al.* 1980). Sixty females were collected, but because of the poor condition of samples, a pregnancy rate could not be determined (Liskop *et al.* 1980). Douglas and Strickland (1987) observed a correlation of pregnancy rate with harvest sex ratio and harvest pressure. The occurrence of barren females because of factors that are not physiological are discussed in Section 2.4.1 *Sex and age ratios.*

Arthur (1988*b*), in a field study in Maine, found a maximum denning rate of 75% (6 of 9 females) during 1985-1987, despite carcass results that suggested pregnancy rates were 95% and greater. During 1987-88, however, all females (n = 4) denned successfully (S. Arthur, pers. comm.). Although these data are few, this is the first documentation that the proportion of females pregnant (determined from a sample of carcasses) is not necessarily the proportion that will successfully whelp young in the wild. Arthur (1988*b*) suggested that reproductive success was dependent on the physical condition of females during fall and winter. I (Banci 1987) described the same pattern for wolverines. Delayed implantation provides females with the option of interrupting pregnancies if females are not in sufficiently good condition during winter. The occurrence of litters of 1 (Table 6 and wild litters in Maine, Section 2.3.1 *Females*) were not apparent from corpora lutea counts (Table 7) and suggest that females may resorb fetuses. I suspect that the denning rates of fishers inhabiting less productive habitats or where severe winters and deep snow levels are present (such as for many habitats in British Columbia) will be lower than for fishers in other habitats.

Table 7. Mean numbers of corpora lutea observed in ovaries of adult females in reproductive studies of fishers.

Corpora lutea $\bar{x} \pm$ sd	*n*	Years	Location	Source
2.6	5	1973	Massachusetts	Cardoza 1979 •
3.3 ± 0.52	11	1977-1979	Maine	Coulter 1966
3.3	994	1972-1983	Ontario	Douglas and Strickland 1987
2.7 ± 0.70	22		New York	Eadie and Hamilton 1958
3.7	12	1976	New Hampshire	Kelly 1977
2.1		1977-1979	Minnesota	Kuehn and Berg 1979 •
3.5	13	1972-1978	Manitoba	Leonard 1986
3.4	17	1976	New Hampshire	Nevers 1979 •
2.7 ± 0.28	25	1975	New Hampshire	Parsons 1979 •
2.3 ± 0.28	18	1976	New Hampshire	"
2.2 ± 0.18	32	1977	New Hampshire	"
3.0 ± 1.04	141	1978-1981	Maine	Shea *et al.* 1985
3.3 ± 0.88	19	1976-1979	Nova Scotia	van Nostrand 1979 •
3.3	44	1950-1964	Maine	Wright and Coulter 1967

• *in* Douglas and Strickland 1979.

Table 8. Age-specific natality of fishers in Maine (Shea *et al.* 1985).

Age (years)	Mean C.L.[a]	SD	Range	*n*
1.5	2.2	1.0	0-4	86
2.5	2.8	1.5	0-5	22
3.5	3.1	1.1	1-5	21
4.5-8.5	3.8	0.8		12

[a] Corpora lutea.

Little evidence is available to suggest if pregnancy rates differ among age classes. In Nova Scotia, 2 females aged 1.5 years, and 2 aged 2.5 years were barren (N. van Nostrand *in* Douglas and Strickland 1979). In Manitoba, barren females were primarily "young" fishers (Leonard 1986), however ages were not given. Douglas and Strickland (1979, 1987) did not report any age class differences in the proportion of barren females in Ontario. However, the oldest ages (>8.5 years) appeared to have had a lower percentage of pregnant females (M. Strickland, pers. comm.).

Males.-- Testes of all age classes of males increase in weight through the winter, in preparation for breeding (Leonard 1980; Douglas and Strickland 1987). By 1 March - 4 April, abundant sperm are present in both the testes and epididymides (Wright and Coulter 1967). The length of time that males remain spermatic, is unknown. A trapped male was spermatic on 4 April in Maine (Wright and Coulter 1967), and during May in Ontario (Douglas and Strickland 1987).

Males are spermatic at 11-12 months of age and their testes are adult size by March (Wright and Coulter 1967; Leonard 1986; Douglas and Strickland 1987). However, the bacula of adults are heavier during March and April (Fig. 5) and differ in shape from the bacula of juveniles (Douglas and Strickland 1987). Because of these differences, juvenile males may be unable to induce ovulation in females (Douglas and Strickland 1987). As the baculum develops under the influence of androgen (Wright 1950), Wright and Coulter (1967) hypothesized that the juvenile bacula would develop into the fully adult type by late spring. Evidence of adult male aggression towards juvenile males (Douglas and Strickland 1987) suggests that even if juveniles are physiologically capable of breeding, adult males may aggressively prevent trespasses, or juveniles may not be socially acceptable to females.

Development of Young.--Fishers are born altricial (Coulter 1966; Powell 1982). The eyes open at 7-8 weeks, the kits can crawl by the end of the eighth week, they can walk by the ninth week, and are able to climb by 10 weeks (Coulter 1966). Kits are independent at 4-5 months (Coulter 1966; Powell 1976). By 5 months, they achieve adult length, but not weight, and sexual dimorphism is evident (Douglas and Strickland 1987). In Vermont, 3 females raised in captivity achieved adult weight at 23 - 24 weeks, but these were fed *ad libitum* (R.W. Fuller *in* Douglas and Strickland 1979). Kelly (1977) reported that young fishers in New Hampshire reached total adult length in their first 8-12 months. Kits are not fully grown by the time they disperse, between late summer and late November (Coulter 1966).

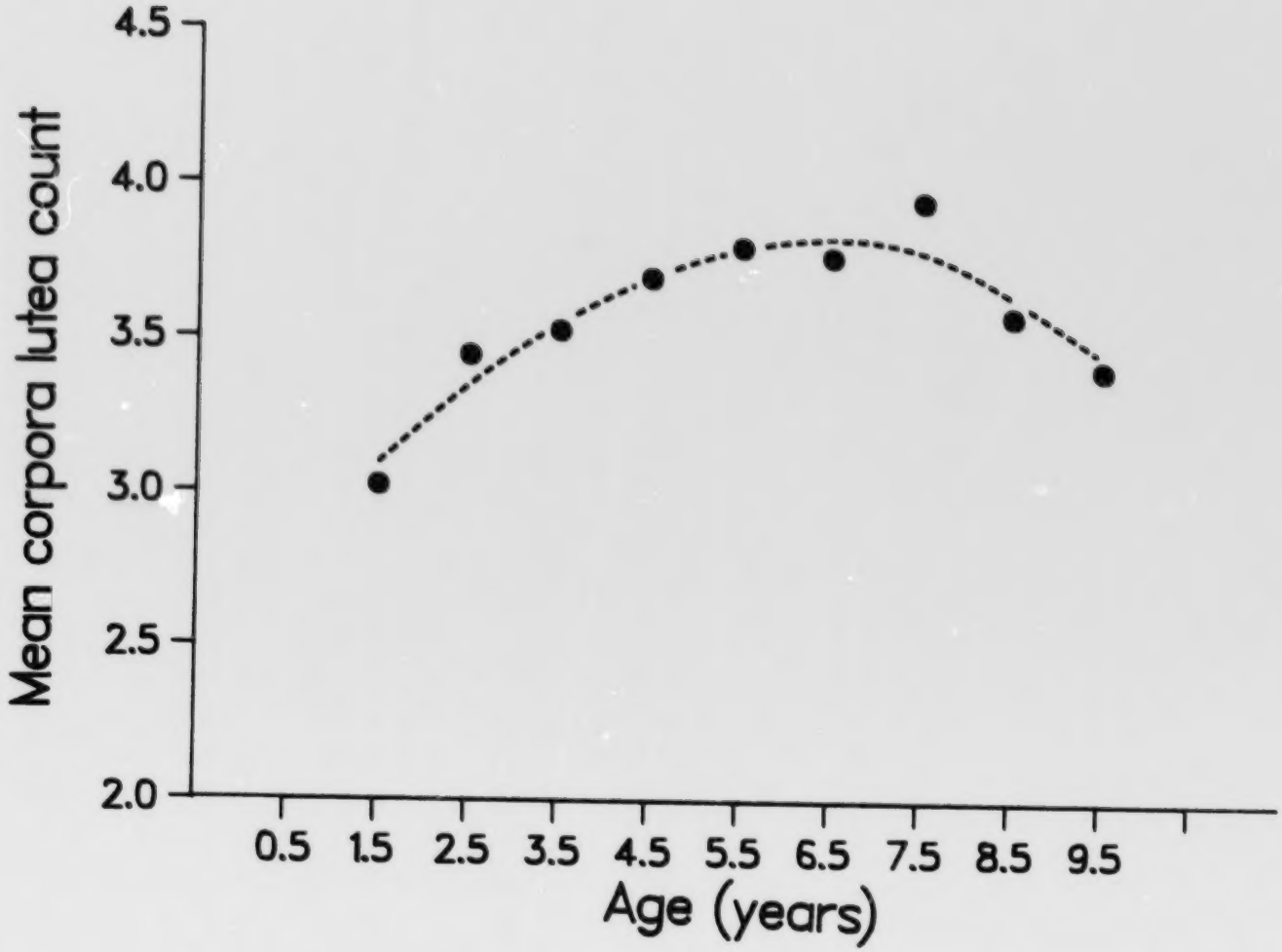

Figure 4. Age-specific natality determined from corpora lutea counts for fishers in Ontario during 1972-1983 (Douglas and Strickland 1987).

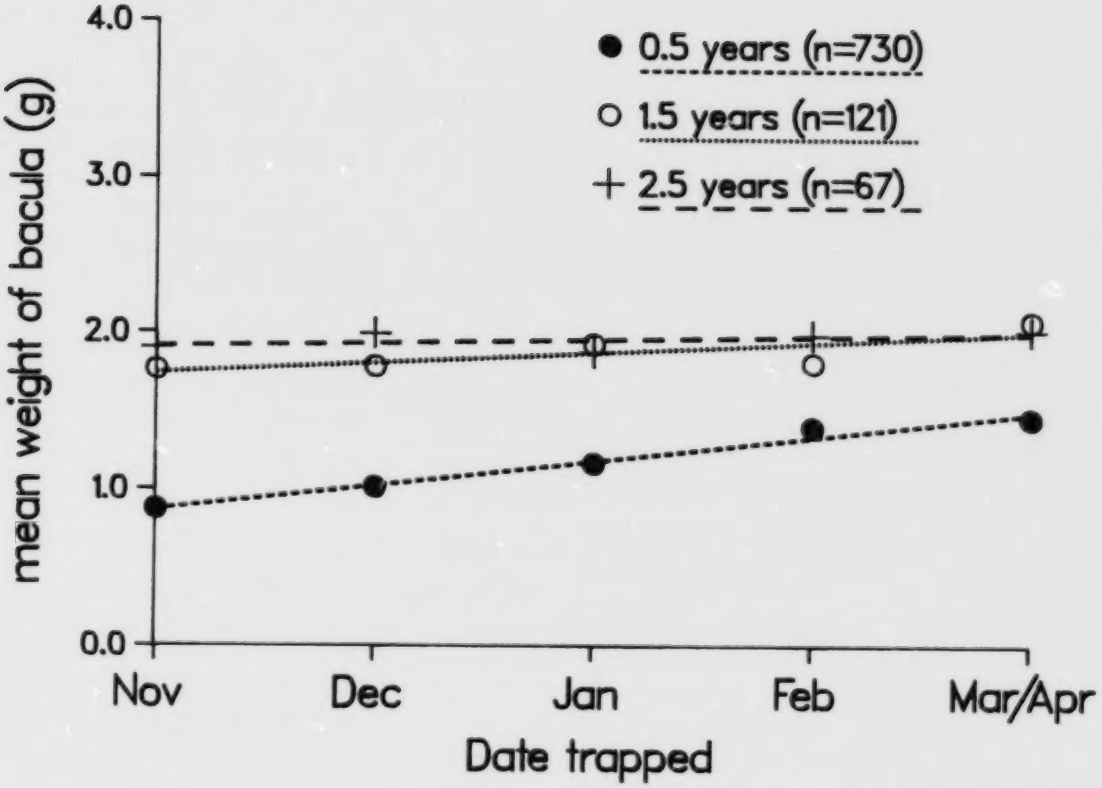

Figure 5. Mean bacula weights for age classes of male fishers trapped during November to April 1972-1981 in Ontario (Douglas and Strickland 1987).

Technical Considerations.-- Corpora lutea may be counted by sectioning ovaries in 1-mm sections with a razor and viewing under a dissecting microscope, or by using histological preparations. In an unpublished comparison, M. Strickland reported that fewer corpora lutea were counted by hand sectioning and suggested that histological preparations provided more accurate results (*in* Douglas and Strickland 1979).

2.3.2. Food and nutrition

Diets.-- As for most mustelids, fishers are opportunistic and their diets are typically diverse. Snowshoe hares and porcupines are frequent prey, if available. Other foods documented in diets are carrion (deer or other ungulate), voles, mice, shrews, moles, muskrat, beaver, rabbit, raccoon, marten, birds (especially grouse and jays), snakes, fish, eggs, vegetation, nuts, apples, beechnuts, and fungi. Although there are several estimates of fisher diets, most are for eastern populations (Table 9) and few data are available for fishers in western North America. Ingles(1965) reported that diets of fishers in Pacific coastal states consisted of porcupine, sciurids, woodrats, mice, marmots, mountain beavers, quails, and grouse. Diets described for fishers in California by Grinnell *et al.* (1937) were similar but included chickarees. Grenfell and Fasenfast (1979) presented results from 8 stomachs of fishers in California. The predominant prey was false truffles, a subterranean fungi (4 of 8). Other prey were white-footed mice, shrews, moles, and sciurids.

A prey group that frequently occurs in fisher diets but is relatively rare in the diets of other carnivores are shrews. Reported frequencies have been 24% (of 242 stomachs) in Maine (Coulter 1966), 15% (of 172, Stevens 1968) and 12% (of 40, Kelly 1977) in New Hampshire, 5% (of 322) in New York (Brown and Will 1979), and 5% and 12% (of 87 and 273, respectively) in Ontario (Clem 1977*a*). Coulter (1966) attributed the consumption of shrews to the use of subnivean crawl spaces for denning by fishers, which also are microhabitats for shrews.

The prey groups snowshoe hare, porcupine, deer, sciurids, small mammals, and birds appear to be staples in the fisher diet. Powell (1982) suggested that small mammals and sciurids were over-represented in diet studies and were consumed fortuitously by fishers. In Michigan, fishers did not hunt in open habitats, areas commonly best for small mammals (Powell 1977). However, the importance of a prey is a relative measure and is a function of prey availability, prey size, and handling time. Smaller prey species may have greater importance in the diet when less larger prey are consumed, i.e., when larger prey are unavailable (Fig. 6). Evidence indicates that fishers select prey on the basis of availability. In Manitoba, during a 3-year increase in the snowshoe hare cycle, the occurrence of small and medium sized mammals in the diet decreased, whereas the proportion of hares increased (Leonard 1980; Raine 1981). During the peak in hare numbers, fishers ate 94% hare, 3% birds, and no sciurids or small mammals (107 scats) (Raine 1981). The next year, the start of the decline phase in the hare cycle, diets (53 scats) consisted of 63% hares, 19% birds, and small mammals and sciurids reappeared in the diet.

Table 9. Studies of fisher diets.

Location	Date specimens collected	Materials	Analyses	Value of study	Authors
Manitoba	1972-1977 5 winters	120 g.i.[a]	. sex . years	Regional	Leonard 1980
Manitoba	1975-1977 2 winters	51 scats	. years	Local	Leonard 1980
Manitoba	1978-1980 Nov-Apr	159 scats		Local	Raine 1981
Ontario (Chapleau)	1946-1951 Nov-Apr	30 g.i.[a]		Limited (small sample)	deVos 1951
Ontario (Chapleau)	1933-1952	59 g.i.[a]		Limited (small sample)	deVos 1952
Ontario (inc. Algonquin)	1973-1974 Nov-Feb	324 g.i.[a] & stomachs	. monthly	Regional	Clem 1977*a*
Michigan	1974-1976 2 winters	35 scats		Limited (small sample)	Powell 1977
New York (Adirondacks)	1949-1953 Oct-Jan	60 g.i.[a]		Limited (small sample)	Hamilton and Cook 1955
New York (northern)	1975-1977 Nov-Jan	322 g.i.[a]		Regional	Brown and Will 1979
New Hampshire	1965-1967 3 winters	172 stomachs	. sex	Regional	Stevens 1968
New Hampshire	1955-1962 yearly	337 scats	. season	Local	Stevens 1968

Table 9, continued

Location	Date specimens collected	Materials	Analyses	Value of study	Authors
New Hampshire	1973-1975 Dec-Feb	40 g.i.[a]		Limited (small sample)	Kelly 1977
Maine	1950-1965 Sep-Apr	242 g.i.[a]	. sex . season	Regional	Coulter 1966
Maine	1950-1964	127 scats		Local	Coulter 1966
Maine	1984-1987 Dec-Mar	68 scats		Local	Arthur 1988
California	1977-1978 Dec-Feb	8 stomachs		Limited (small sample)	Grenfell and Fasenfast 1979

[a] g.i. = gastro-intestinal tracts.

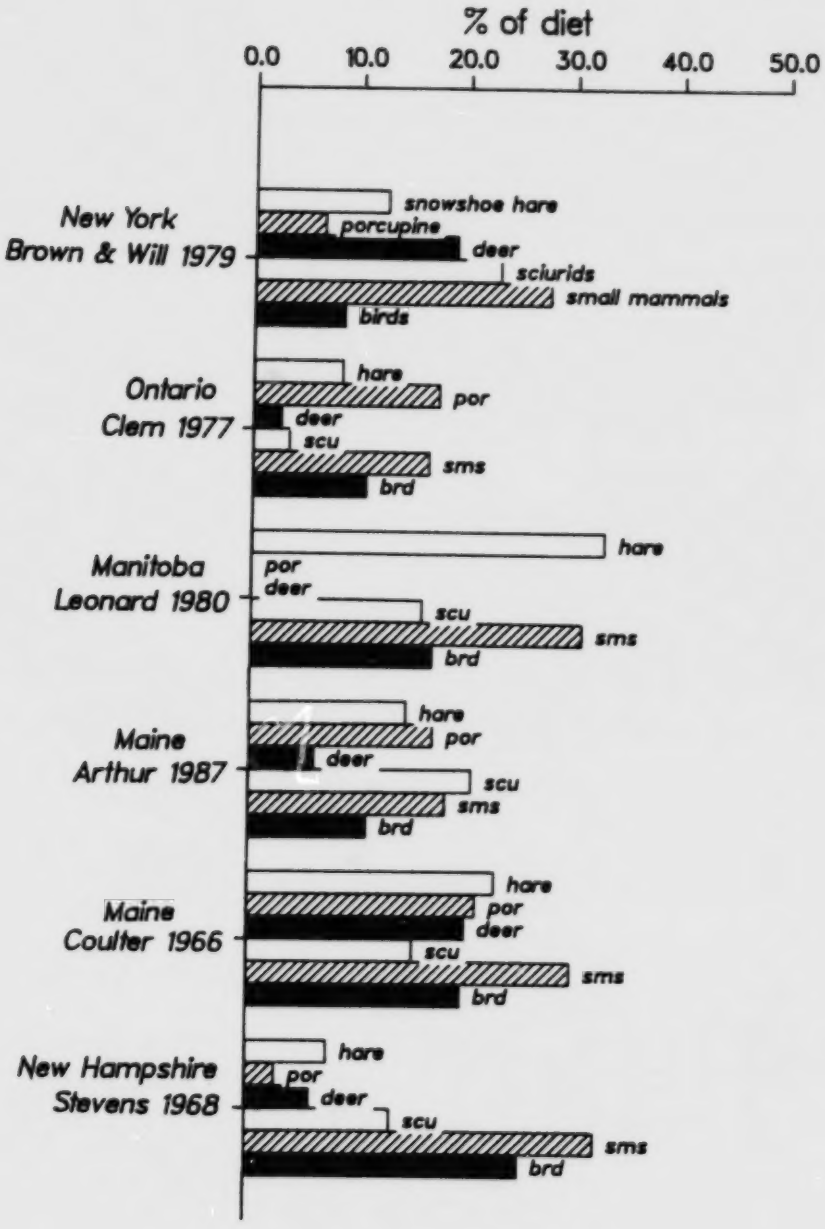

Figure 6. The relative importance of snowshoe hare, porcupine, deer, sciurids, small mammals, and birds in estimated diets of 6 fisher populations.

Carrion may also display periods of seasonal abundance. During a severe winter in Minnesota, deer mortality was high and provided an abundant food source for scavengers (Kuehn and Berg 1979). The incidence of deer in the diet of fishers that year increased to 31%, from 19% the previous year. The frequency of mice decreased from 14% to 4%, while the proportion of snowshoe hares remained constant at 36%. In Manitoba, ducks were frequent in diets of fishers, particularly during early winter when large migratory flocks frequented the area (Leonard 1980). Similarly, and also in Manitoba, muskrats were common in shallow bays of lakes and were important in diets of fishers (Raine 1981).

Apples were important in the winter diets of fishers in New Hampshire (30.7%, Stevens 1968), and were the most frequently occurring food in diets of Maine fishers (33.8%, Arthur 1987). Apples were not eaten because other prey were scarce; all fishers had fat deposits and apparently were in good condition (Stevens 1968). The consumption of fruit appears to be an opportunistic response reflecting habitat selection. In both studies, habitats used by fishers were abandoned farmlands in the process of reverting to forests. Apples were common in these habitats and were not eaten to the exclusion of animal prey.

No one species within a prey group exceeds all others in importance. Red squirrels are ubiquitous in coniferous forests and frequently occur in fisher diets. Powell (1982) suggested that the incidence of chipmunks may be greater in summer diets because of their greater availability (Powell 1982). White-footed mice, red-backed voles, and meadow voles are generally the most common mice in the fisher's habitat. In Maine, fishers actively hunted mice in rotted stumps and logs, as apparent by the scattering of mouse nests and their stores of seeds (Coulter 1966). As corvids also scavenge, fishers may consume jays and crows at ungulate kills (Coulter 1966).

Most ungulates are consumed as carrion (Coulter 1966), although there is one record of a fisher attacking a white-tailed deer fawn (Pringle 1964). Powell (1982) noted that highway killed deer was a source of carrion unrelated to the trapping season, with peaks at different times of the year. Carrion in the form of white-tailed deer was apparently plentiful during winter in Ontario (deVos 1952). Kill sites continue to be important to fishers even after all the meat is gone (Coulter 1966; Powell 1982). Fishers have been known to den up next to an old kill from several days to a few weeks (deVos 1952). In Maine, repeat visits to carcasses lasted from 6 consecutive days to occasional visits for up to 4 months (Coulter 1966). Fishers tended to return to old kill sites during cold, stormy weather (Coulter 1966), times of low food availability. Deer hair occurred in scats during much of the winter but this occurrence did not reflect consumption of deer meat because most hair originated from scavenging from pelts (Coulter 1966). Wolverines in arctic Alaska also relied on bone and pelt from old kill sites as food during winter when ungulates were unavailable (Magoun 1985).

Because fishers are trapped, bait may occur in diets determined from stomach contents. Separating carrion that is bait from carrion attributable to natural sources may be difficult. However, Kelly (1977) stated that "trap bait is a legitimate component of the fisher's diet during the trapping season". Strickland and Douglas (1987) observed that the return of carcasses to traplines in Ontario was a common practice and provided food for furbearers. Thus, the incidence of carrion in diets, whether natural or provided by man, will reflect the availability of that food in the environment and it may not be important to distinguish between sources.

Scavenging is an important foraging behaviour of mustelids but its incidence is difficult to quantify. Not all scavenges of fishers consist of ungulates. Muskrats frozen out of their pushups in November and December were sources of carrion in Manitoba (Leonard 1980). Fishers also scavenged from hares, grouse, and red squirrels (Raine 1981). Powell (1978, 1979) reported an average of 1 kill or scavenge/7.7 km of trail for fishers in Michigan, Leonard (1980), 1/10.7 km in Manitoba, and Raine (1981), 1/5.1 km also in Manitoba. What constitutes the scavenging/foraging rate in good habitats versus poor habitats is unknown.

The hibernating species, jumping mice, woodchucks, and snakes, occurred in diets of Ontario fishers during winter (Clem 1977*a*) and in diets of fishers in Manitoba (Raine 1981). Raine (1981) observed that grouse eggs were obtained by digging through the snow in mid-winter, but he did not know whether these were whole eggs or shell fragments. Seton (1926) suggested that caching by fishers was common however this behaviour has been rarely mentioned in subsequent studies. Cached deer was important to fishers during severe winters in Maine and fishers observed in captivity displayed caching behaviour (Coulter 1966). Mustelids are known to cache food (Oksanen 1983), and hibernating species in the diets of Alaskan wolverines were previously cached prey (Magoun 1987). Fishers probably also display caching behaviour and hibernating species in diets may be due to this source.

Powell (1977) suggested that fishers should prefer snowshoe hares and deer to porcupine, because of the high energy content of the former species and the high handling time of porcupine. The consistently high frequency of snowshoe hares in diets is expected because the range of fisher is within that of snowshoe hare (Powell 1982). The prey switching that occurs during a hare increase and decline (Leonard 1980; Raine 1981) or during an abundance of carrion (Kuehn and Berg 1979) not only indicate that fishers are adaptable, but suggest that prey diversity is an important habitat requirement. Habitat studies indicate that fishers frequent ecotones and riparian areas, and are more abundant in forests that are not monotypical, all areas of high prey abundance (Section 2.3.3.).

a. Seasonal diets.-- Most diets that have been estimated for fishers are for winter; few quantitative data are available for summer diets. Stevens (1968) indicated an increased incidence of vegetation, during summer and fall, especially fruits and nuts. His sample was not representative of all fishers because of the presence of a female and her kits in the area when scats were collected (Stevens 1968). However, summer diets are likely to be more varied because of the increased diversity of prey. Steven's (1968) study provides the best information on yearly trends (Fig. 7). Deer (carrion) in the diet peaked during winter and spring, consistent with patterns in ungulate mortality. The importance of snowshoe hare and sciurids increased over winter while the frequency of moles and shrews, and fruit decreased. Mice and birds were consumed all year.

Coulter (1966) analyzed diets of fishers in Maine using 3 seasons, autumn: late September - 30 November (n = 85); early to mid-winter: 1 December - 31 January (n = 99), and late winter: 1 February - early April (n = 48). Although representing a narrower time period, Coulter's (1966) results are similar to those of Stevens (1968). Stomachs of fishers trapped during fall and early winter had a greater variety of foods than those of fishers trapped in mid-winter. Of the 3 seasons, Coulter (1966) noted that autumn had the maximum in potential types and abundance of prey. Trends evident in his data were an increase in the consumption of hares, deer, sciurids, and birds from autumn to late winter, and a decrease in the consumption of shrews during late winter. Frequencies of porcupines and mice did not differ among the 3 seasons.

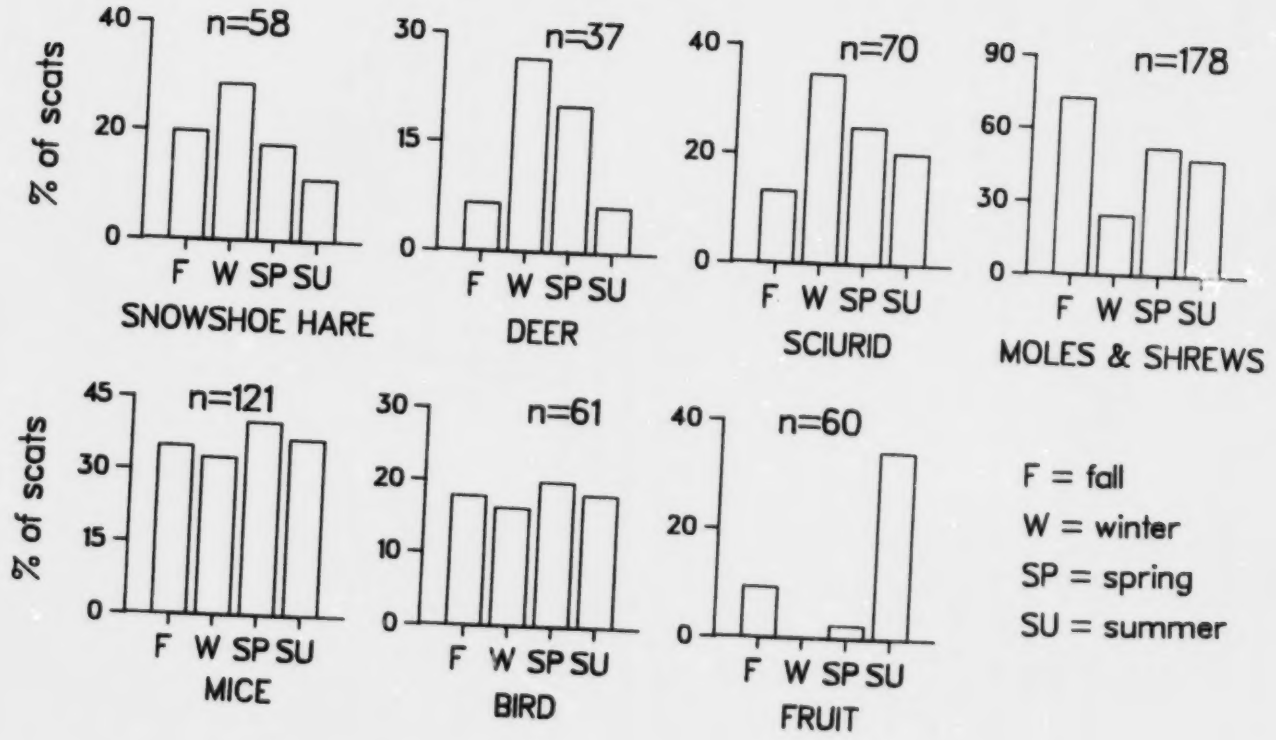

Figure 7. Seasonal diets of fishers in New Hampshire, determined from 333 scats (Stevens 1968).

Similarly in Ontario, foods consumed during November were most different from those prey consumed from December to February (Clem 1977*a*). The frequency of porcupines decreased after November, as did sciurids (Fig. 8). Snowshoe hares and muskrats were eaten all winter. Frequencies of sciurids and small mammals decreased during December, while the incidence of deer increased, possibly indicating a prey switch with a greater abundance of carrion. The consumption of birds, sciurids, and small mammals increased and the percentage of empty stomachs decreased as winter progressed. Thus, if foods were less diverse later in the winter, they were not necessarily less abundant. Unfortunately, Clem (1977*a*) was unable to document prey availability.

b. Sex and age differences.-- Few differences in diets were apparent between sexes of fishers in Maine (Coulter 1966), New Hampshire (Stevens 1968), and Ontario (Clem 1977*a*). The differences observed, however, indicate that in some localities and at certain times, females may consume a greater proportion of smaller prey (Table 10), and they may be more efficient at finding food (7% empty stomachs vs 20% for males in New Hampshire, Stevens 1968). Porcupine quills were found more frequently in males (Kelly 1977; Leonard 1980; Rego 1984; Strickland and Douglas 1987). Of Kelly's (1977) livetrapped fishers, 1 female and 12 males were pierced by quills. Arthur (1987) found no fresh porcupine quills in females but 12 of 28 males had quills. In Manitoba, females apparently consumed more snowshoe hares during 1974-75 (30% versus 8% males) and during 1975-76 (28% versus 17% males) but these differences were not significant because of small samples (Leonard 1980). During 1976-77, the peak in the hare cycle, sexes did not differ in hare consumption (43% female, 55% male) (Leonard 1980). Diets of sexes may differ during summer and fall when females are providing for kits but these data are unavailable.

Hunting Behaviour.-- Powell (1977) described the hunting behaviour of fishers in Michigan. Porcupine hunting was characterized by long distance (up to 5 km), straight line movements directed to porcupine dens. Foraging for porcupines was largely confined to hunting in open, upland, hardwood forest. Fisher tracks in hardwood forests in Ontario were also in straight lines (Clem 1977*a*).

Fishers kill porcupines by repeated attacks to the unquilled face, a method apparently unique to this species (Coulter 1966). Fishers are adapted to killing porcupine by being low to the ground, large enough to inflict wounds, and yet small and agile enough to avoid tail swipes (Powell 1977). The size of a porcupine may determine the success of predation by fishers (Powell and Brander 1977). Smaller fishers, such as females, may not be able to kill large porcupines, those 3-4 years old or more than 7 kg in weight (Powell and Brander 1973; Earle 1978).

For all prey other than porcupine, including snowshoe hares, hunting behaviour of fishers is characterized by frequent changes in direction and zig-zags (Powell 1977). Fishers in Manitoba hunted opportunistically, using habitat features such as overturned tree roots and brush piles to facilitate attacks on prey (Leonard 1980). The use of downed logs was a dominant feature of hunting behaviour (Leonard 1980), confirming deVos's (1951) observation that fishers have a "liking" for walking on fallen logs.

Table 10. Differences between sexes in diets of fishers from Maine (Coulter 1966), New Hampshire (Stevens 1968), and Ontario (Clem 1977*a*).[a]

Prey	Females		Males		*p*	Source
	%	*n*	%	*n*		
White-tailed deer	20	129	29	113	0.10	Coulter 1966
Shrews	29	"	20	"	0.10	
Empty	7	103	20	71	0.05	Stevens 1968
Fruit	27	96	44	57	0.05	
White-tailed deer	4	"	12	"	0.10	
Sciurids	21	"	9	"	0.05	
Porcupine	25	125	38	95	0.05	Clem 1977*a*
Small mammals[b]	30	"	19	"	0.10	(1974 data)
White-footed mice[b]	14	"	4	"	0.05	

[a] All diets were estimated from the contents of gastro-intestinal tracts and significance was determined from Z-tests.

[b] Among meadow voles, white-footed mice, and shrews, the only prey species that differed between diets was the white-footed mouse.

Energetics and Health.-- a. Food requirements and energetics.-- In feeding trials, Davison (1975) determined that cotumix quails and white-tailed deer were the most nutritious of 4 prey groups, in that they provided the most energy. Snowshoe hares and small mammals had lower digestibilities but hares contributed the most protein. Davison (1975) hypothesized that hares were the best food for growing fishers because of the high conversion of dietary nitrogen to body tissue. Powell (1977, 1981) provided estimates of daily energy expenditures for free-living, radio-collared fishers of 200 - 450 kcal. These estimates are equivalent to 1 hare every 2 - 5 days, 1 porcupine a month, 1/4 - 1/2 kg of deer carrion a day, 1/2 - 1 1/2 squirrels a day, or 5 - 22 mice per day (Powell 1981).

The energy expenditure for a lactating female fisher was estimated by Powell and Leonard (1983). The non-reproductive energy expended (by a 2.64 kg female) during early lactation was predicted to be 970 kJ/d when kits were 13-56 days old. Lactation required 542-1006 kJ/d, approximately 40% of the total energy expended. Other costs increased from 899 to 1330 kJ/d, due to an increase in activity by females when securing food for kits. When kits were 7 weeks old, 2270 kJ/d was required, 2.3 times the needs of a non-reproducing female fisher. Since weaning is incomplete until kits are at least 10 weeks old, energy expenditure could reach 2500-2900 kJ/d, almost 3 times the non-reproductive expenditure. The large energy output required by reproduction explains why selection has favoured a smaller size in females (Powell and Leonard 1983).

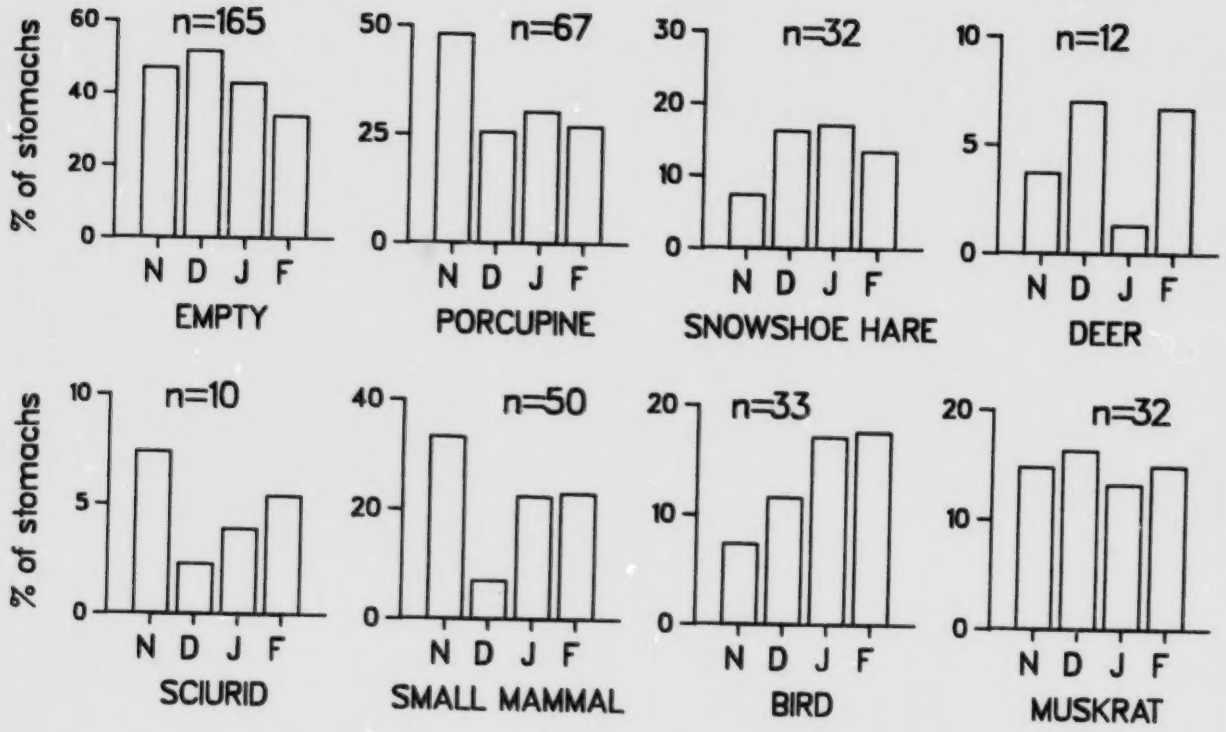

Figure 8. Monthly winter diets of fishers in Ontario determined from 220 stomachs (an additional 165 were empty)(Clem 1977*a*).

b. Condition and fat indices.-- Indices to condition are typically related to fat, such as the kidney fat index (Riney 1955), visual estimates of body and internal fat, weights of internal organs and associated fat, or body weights. The difficulty with such indices is that their relationship to the health of an animal is unknown. A relatively lower percentage or level of fat in an animal does not imply it is in worse condition than an animal with a higher fat level. These concerns need to be considered when assessing condition of fishers by changes in body weight or fat indices.

In Ontario, weights (determined from carcasses) were lowest for both sexes in December, and highest in February for males, and in November for females (Clem 1977*a*). Explanations based on health need not be evoked. Most juveniles are trapped early in the season (Section 2.4 Population Dynamics) and juveniles weigh less than adults (Section 2.2 Description). In New Hampshire, live fishers lost weight during late winter and spring (Kelly 1977). Rego (1984) used fat indices to suggest condition was best in November, likely because food abundance was greater and climatic conditions were less stressful.

A sample of 22 fishers collected during the 1940's and 1950's in Ontario had low fat levels (deVos 1952). In Maine, specimens from southern regions containing productive habitats, were "exceptionally" fat (Coulter 1966). Over 90% of fishers in Ontario had body fat deposits (Douglas and Strickland 1987).

Coulter (1966) reported that males always had more fat in relation to body size. In an "exceptionally" fat male, weights of external and internal fat were 17% of the estimated live weight, and 9-13% for 3 other males (Coulter 1966). Two "exceptionally" fat females had weights of fat that were 6-8% of estimated live weights (Coulter 1966). In Ontario, adults had the least amounts of fat, and males usually had more fat than females (Douglas and Strickland 1987). Similarly, Clem (1977*a*) reported that wet weights of organ and mesentery fats were higher for males during all months of winter. Because the slope of the relationship between body size and total body fat is >1.0 (Lindstedt and Boyce 1985), a sexually dimorphic species would show large differences in the weight of fat that sexes maintained, proportional to body weight. Thus, the above results do not confirm that males are in better condition than females.

Most studies use trapped fishers and results are not indicative of yearly fat levels but represent a short period during early winter. It may be more important to examine energy losses during reproduction. Lactation is energetically expensive (Section 2.3 Life History and Behaviour) and the energy reserves of females are more likely to be depleted after having young. Such information cannot be obtained from trapped samples.

c. Mortality agents and parasites.-- The general decline in fisher populations during the late 1800s and early 1900s was due to overtrapping, non-selective predator control, habitat reduction, logging, and fires (Williams 1962; Brander and Books 1973; Douglas and Strickland 1987). Fishers appear to have few enemies besides humans (Powell 1980; Douglas and Strickland 1987) and records of natural mortality agents are rare. Two fishers were killed by mountain lions in California (Grinnell *et al.* 1937). Raine (1981) believed a young male died of starvation in Manitoba. He hypothesized that heavy snow cover posed undue stress on fishers. Douglas and Strickland (1987) cited intraspecific strife, particulary between adult and juvenile males, as a possible contributor to natural mortality. Pelt scarring was most frequently observed in juvenile males (53%, 163/307), and secondly in adult males (42%, 47/113) (Douglas and Strickland 1987).

Rates in females were 16% (50/305) for juveniles and 5% (7/153) for adults (Douglas and Strickland 1987). Leonard (1980) described the incidence of fractured zygomas in skulls of male fishers, an injury never observed in females. Aggression between adult and juvenile males is likely most frequent during the breeding season.

Although a variety of endo- and ecto-parasites infest fishers (reviewed in Powell 1982; Douglas and Strickland 1987; and references in bibliography), apparently very few have ill effects. The only report of an endoparasite that caused considerable damage was a liver fluke in a fisher from Manitoba (R. Leonard *in* Douglas and Strickland 1979). Furbearers are not seriously compromised by parasitic infections other than sarcoptic mange (Addison *et al.* 1987). Mange is a contagious skin disease caused by a mite, *Sarcoptes scabei*, and it has been documented on fishers (O'Meara *et al.* 1960, Coulter 1966). The pelt is damaged and mange can be a serious mortality factor under some conditions (Addison *et al.* 1987). Canine distemper is an invariably fatal viral disease that has been documented in fishers from New York (Monson and Stone 1976). Because routes of transmission are direct contact and by aerosol, the occurrence of distemper is primarily a function of densities (Monson and Stone 1981). As fishers typically occur in low densities, the incidence of this disease is likely to be low.

In any sample of live fishers or carcasses, a proportion is pierced by porcupine quills, 28% (of 18) in British Columbia (Quick 1953), 33% (of 365) in Maine (Coulter 1966), 15% (of 89) in New Hampshire (Kelly 1977), and 9% (of 3464) in Ontario (Douglas and Strickland 1987). Quills carry no poisons or irritants and have no characteristics that could cause infections but injuries occur occasionally. deVos (1952), Hamilton and Cook (1955), Morse (1961), and Coulter (1966) cite instances in which quills have caused blindness in fishers when imbedded in the face. Powell (1982) reported of a quill imbedded in a fisher's chest that became infected and needed treatment. "Because fishers have developed a technique for killing porcupines that minimizes the chances of receiving a large number of quills, they are less likely than other predators to suffer serious problems from porcupine quills" (Powell 1982). It may not be the quills of a porcupine that pose a source of injury. O'Meara *et al.* (1960) suggested that porcupines were a possible transmission agent of sarcoptic mange.

2.3.3. Habitat use

Descriptions of habitat use of fishers and quantitative studies are biased to habitats in eastern North America. Both sexes of fishers in New Hampshire used wetland associated forest types (riparian or low lying areas) and mixed softwood-hardwood types in greater proportion than available, and hardwood types less than available (Kelly 1977). Edge habitats were used more than expected in winter by both sexes. Clearcut forest types (characterized by high stem densities of pioneer species such as cherry, aspen, and paper birch, and with crown closures of approximately 100%) were used less than available in winter but more than available in summer. Fishers foraged in clearcuts as prey abundance (small mammals) in these habitats was above average. Prey abundance was also above average in wetland and softwood-hardwood habitats, but below average in hardwood habitats.

Productive habitats in Maine were abandoned farmlands, consisting primarily of second-growth forests, interspersed with small farms and pastures (Arthur 1987). In both Ontario and New York, fisher harvests were greatest in habitats just out of agriculture (*in* Douglas and Strickland 1979).

All aerial locations (n = 782) in Maine were in forested habitat, although only 83% of the study area was forested (Arthur 1987). Deciduous stands were used proportionately less than available, during all seasons. Coniferous stands were used more in all seasons except summer. Mixed stands were used in proportion to availability during all seasons. Scrub stands were used less during winter and spring. Wetlands were used less in all seasons but more during fall. Stands with no understory and sparse coniferous understories were used most frequently. However, the use by fishers of dense patches containing snowshoe hare trails was underestimated.

Clem (1977*a*) reported that fishers used mixed forests frequently in Ontario. Douglas and Strickland (1987) assessed habitat use by questionnaires to Ontario trappers (n = 683). Results were generally consistent with those of Kelly (1977), Arthur (1987) and Clem (1977*a*), swamp - 23%, old mixed hardwood/softwood - 21%, young mixed hardwood/softwood - 21%, old hardwood - 11%, and old conifer - 6%. Mixed forests were used more often than mature coniferous forests in all areas.

Schempf and White (1977) assessed fisher habitat use in California through the use of observations. In the North Coast Region, which supported the densest fisher population in the state, 48% of 108 sightings were in Douglas-fir habitats and 38% in mixed conifer. Fishers were rare in the South Sierra, where habitats were predominately mixed conifer, and in the North Sierra, which consisted of mixed conifers at high elevations.

Edwards (1950) suggested that the distribution of fishers in British Columbia indicated that they were not as dependent on climax coniferous forests as are marten. Unfortunately, the only analyses of fisher abundance in the province are based on trapline returns from 1929 to 1948 (Edwards 1950; MacLeod 1950). Current harvests support Edward's (1950) observations that fishers are absent near the tree line in northwestern British Columbia and that they are rare in the Coastal Forest of British Columbia. Their rarity in the latter region may be because of deep snow levels (Sections 2.3.3 and 2.3.5).

A high degree of diversity and interspersion appears to be critical habitat needs for fishers. Edges or ecotones were used extensively by fishers in New Hampshire (Kelly 1977), Wisconsin (Johnson 1984), Ontario (Clem 1977*a*), and Manitoba (Leonard 1980). The importance of these habitats may be seasonal. In New Hampshire, edges were used in proportion to availability during winter, but more than available in summer (Kelly 1977). The importance of riparian and wetland associated areas was initially documented by Seton (1926) and has been confirmed for fishers in New Hampshire (Kelly 1977), Manitoba (Leonard 1980; Raine 1981), and Wisconsin (Johnson 1984).

Although individual variability was apparent, generally fishers in New Hampshire used elevations of 329 - 607 m more than the 608 - 911 m and >911 m categories (Kelly 1977). Females used higher elevations ($\bar{x}$ = 505 ± 121 m) than did males ($\bar{x}$ = 446 ± 82 m). Grinnell *et al.* (1937) reported that fishers in California used lower elevations in summer but Kelly (1977) in New Hampshire and Buck *et al.* (1979) in California did not observe any seasonal shifts.

Forest Cover.-- Several researchers have documented that fishers avoid habitats lacking overhead cover. Fishers in Michigan did not use open areas, and if they crossed them, they ran (Powell 1977). deVos (1951) stated that fishers avoid recently logged and burned habitats. In deVos (1952), however, he presents trapper reports which maintain that fishers cross large lakes and extensively

burnt areas. This activity may be more prominent during the breeding season (deVos 1952). The presence of a wide river in Maine apparently slowed the dispersal of fishers into suitable habitats, and was attributed to the lack of cover (Coulter 1966). Fishers avoided crossing fields or frozen lakes and seldom crossed roads or highway right-of-ways in Maine (Coulter 1966).

Fishers in Manitoba did not avoid open spaces (bogs and lakes), but they did not hunt in them (Raine 1981). Forest cover may be more important during winter, and for certain activities such as resting. In New Hampshire, habitats with little cover were used most often in summer (Kelly 1977). Stationary fishers (presumably resting) were located less than expected in clearcuts during summer although clearcuts were important habitats for foraging (Kelly 1977). Forest cover was not a primary factor in habitat selection for fishers in Wisconsin (Johnson 1984). Monotypic forests providing year-round cover were rarely used, probably because of the lack of structural diversity (and low prey diversity) (Johnson 1984).

Snow Cover.-- deVos (1952) reported that deep snow hindered the movements of fishers in Ontario. Leonard (1980) and Raine (1981) demonstrated that habitat use by fishers in the Boreal Forest of Manitoba was altered by the thick, soft snow cover of mid-winter. Fishers used different cover types and changed their activity patterns to cope with snow levels. After the first thaw and formation of a crust, changes in activity and habitat use were noted. For example, open bogs were not used from November to January (Leonard 1980). In February, these were the only habitats with supportive crusts and fisher activity was observed (Leonard 1980). In deep snow, the use of coniferous ridges (and therefore the use of forest cover) was greater than expected (Raine 1981). During crust conditions, all habitats were used in proportion to availability (Raine 1981).

Energetic costs are large; fishers active on soft snow may use an estimated 54% more energy per day than fishers on hard snow (Leonard 1980). Because of their larger size, fishers are affected to a greater extent than are martens (Leonard 1980; Raine 1981). Snow cover may be an important factor in understanding differences between the distributions of fishers and marten.

Resting Sites and Natal Dens.-- deVos (1952) stated that fishers were not particular with respect to their choice of resting sites; "any kind of hole" was suitable. Locations which have been used for resting sites are diverse (Table 11). In Michigan, snow dens (10/31), hollow logs (9/31), and holes in the ground (8/31) were used (Powell 1977). In Maine, witches brooms, clumped growths in balsam fir, were used most often all year (Arthur 1987). The use of squirrel and raptor nests (Arthur 1987) indicate that fishers are opportunistic in their choice of resting sites. In Ontario, fishers used abandoned beaver houses (deVos 1952), and a temporary den was located in the body cavity of a dead white-tailed deer (Douglas and Strickland 1987).

Seasonal differences occur in the selection of resting sites. In Maine, ground burrows (probably excavated by woodchucks), were used more in winter (Arthur 1987). Tree cavities were used more during the cool nights (<0 C) of fall and spring (Arthur 1987). Attempts at documenting the characteristics and densities of resting sites are few. Resting sites in California were associated with snags and downed logs of 75-100 cm dbh (Buck *et al.* 1979). Resting sites in Michigan were used a maximum of 1 day (Powell 1977), they were rarely re-used in Maine (Arthur 1987), and in Manitoba, a fisher used a resting site sporadically for about 30 days (Raine 1981). There may be a correlation between the density of resting sites and the frequency of their re-use. Fishers may re-use resting sites if a source of abundant food, such as an ungulate kill, is nearby (Coulter 1966).

Table 11. Resting sites and natal dens used by fishers.

Resting Sites		Natal Dens
-snow dens	3,11	
-hollow logs	2-4,9,11,13	5
-holes in ground	1,4,11	
-tree cavities	1,8,9,11	1,5-8,11-13
-hollow stump	11	
-rock fall and ledges	8,9,11,13	5
-witches brooms	1	
-squirrel nests	1	
-raptor nests	1	
-under boulders	3,12	
-under upturned tree roots	4,12	
-under branches of fallen tree	12	
-under logs	10	
-brush piles	3,4	

1 - Arthur 1987, 2 - Bradle 1957, 3 - deVos 1952, 4 - Coulter 1966, 5 - Grinnell *et al.* 1937, 6 - Hamilton 1957, 7 - Hamilton and Cook 1955, 8 - Ingram 1973, 9 - Kebbe 1961, 10 - Leonard 1980, 11 - Powell 1977, 1982, 12 - Raine 1981, 13 - Seton 1926.

Natal dens were most often in cavities of large, dead trees (Table 11), situated 7 to 12 m above the ground (Seton 1926; Leonard 1980). In Maine, females (n = 10) used tree cavities exclusively for natal dens (S. Arthur, pers. comm.). Requirements for natal dens appear to be more specific than for resting sites (Table 11). Tree cavities provide thermal protection for kits, protection from adult male fishers, and security from predators (Leonard 1980; Allen 1983). A secure den is especially important considering a female may leave her kits unattended for long periods (Leonard 1980). A female and her kits in Manitoba abandoned a tree den on 27 May, before the kits were independent (Leonard 1980). Leonard suggested (1980) that she had moved her kits to a ground den when they became active. Use of different natal dens according to the age of kits was documented for martens in Maine (Wynne 1981) and probably also occurs in fishers.

Optimal Habitats and HSI Models.-- The optimal habitat for fishers is a function of the habitats available. Allen (1983) suggested optimal habitat was mature conifer forest. As stated by Arthur (1987), this is likely true where deep snow restricts movements. Arthur (1987) suggested that habitat quality (in Maine) decreased when stands had greater than 75% conifers. The ideal habitat in Oregon was described as "dense mature forests, close to climax, with a large percentage of coniferous trees and many windfalls" (Ingram 1973).

The habitat suitability index (HSI) is a measure of the relative value of a species' habitat, and generally is determined for a specific area. Allen (1983) developed an HSI model for application throughout the range of the fisher, and for year-round habitat requirements. The model was developed for the cover types Evergreen Forest, Deciduous Forest, Evergreen Forested Wetland, and Deciduous Forested Wetland. The habitat variables selected as best providing for fisher requirements were V1 -Percent tree canopy closure, V2 -Average dbh of overstory trees, V3 -Tree canopy diversity, and V4 -Percent of overstory comprised of deciduous species. The suggested equation for obtaining a winter cover value was:

$$HSI = (V1 \times V2 \times V3)^{1/3} \times V4.$$

Thomasma (1988) provided the first attempt at verification of this model. Her study area was in the Ottawa National Forest, the location of Powell's (1977) research. During winter, an HSI was calculated for habitat at each fisher track (n = 132) found on previously determined systematic transects. Habitat availability was estimated during summer and fall using the same transects (n = 497 plots). Infra-red United States Forest Service photos and maps were used for a second HSI determination. The model provided reliable results for most habitat types, when habitats were classified with ground plots. Predicted HSI values were too high within pine plantations. Fishers used higher HSI value habitats with greater frequency than expected if use was proportional to availability and fisher habitat preference was positively correlated with HSI values. The accuracy with which habitats were delineated in Forest Service data, however, appeared to be too low for determining valid HSI values for fisher.

2.3.4. Home range use and movements

Early estimates of home range size and movements of fishers were determined using snow tracking and harvests (deVos 1951, 1952; Quick 1953; Coulter 1966). Kelly (1977) provided the first estimates using radio-telemetry for fishers in New Hampshire. Subsequently, home ranges were determined for fishers in California (Buck *et al.* 1979), Manitoba (Raine 1981; Leonard 1980), Wisconsin (Johnson 1984), and Maine (Arthur 1987). Buck *et al.* (1979) presented the first year results of an intensive study in California. Intensive monitoring during March-May (346 locations) provided detailed information on the activity and home range use of a lactating female in Manitoba (Leonard 1980). Raine (1981) provided mid-winter home range sizes for 2 juvenile females. Johnson's (1984) study was limited to 1 year and sufficient data were obtained for only one fisher, an adult female. He did, however, estimate monthly ranges. Arthur (1988) captured and collared 43 fishers over 4 years. His research has provided the most reliable estimates of home range size, for the largest sample.

Yearly Home Ranges.-- Snow tracking typically overestimates home range sizes. deVos (1952) suggested fishers used circuital ranges and estimated home range dimensions as 13-32 km in diameter and 64-160 km in length. Estimates determined by radiotelemetry indicate that mean yearly home ranges are smaller, ranges of adult males are 20-34 km^2, and for adult females, 15-19 km^2 (Table 12).

Table 12. Yearly home range sizes of sex and age classes of fishers, determined using radio-telemetry.

Location	Age/sex	*n*	$\bar{x}$ ± sd (km^2)	Time of year	No. of locations	Source
New Hampshire	Adult F	2	15.1 ± 3.7	Nov-Sep	7-70	Kelly 1977
	Adult M	3	19.7 ± 17.5	Dec-Jun	"	
	Juvenile F	3	15.1 ± 5.9		"	
	Juvenile M	3	25.6 ± 16.6		"	
California	Adult F	1	3.6	Feb-Jul	12	Buck *et al.* 1979
	Adult M	3	14.0 ± 3.7	Nov-Sep	43-51	
Manitoba	Juvenile F	2	17.7 ± 3.9	midwinter	25-45	Raine 1981
Wisconsin	Adult F	1	14.3	Aug-Apr	193	Johnson 1984
	Adult M	1	22.7	Aug-Dec	26	
	Juvenile M	1	41.2	Feb-Aug	83	
Maine	Adult F	6	16.3 ± 11.4	May-Dec	50 *	Arthur 1987
	Adult M	7	30.9 ± 24.6	May-Dec	50 *	

* 50 independent locations selected from totals of 52-623.

Calculations of home range size are not consistent, even within a species. "Yearly" home ranges are not necessarily calculated using a year's worth of data (Table 12). Kelly (1977) suggested that a fisher's "yearly home range can be estimated by locations obtained every 1 or 2 days for 7 days during any 2 week period". However, information on the sample sizes and the effort necessary to estimate yearly home ranges of fishers accurately were unavailable to Kelly. Even with the benefit of radiotelemetry, an adequate number of locations may be difficult to obtain. Because of differences among studies and because fishers need not necessarily maintain a home range for an entire year, reported home range sizes should be considered with respect to the dates when locations were obtained.

Observed ranges indicate individual variability. The maximum home range size for adult females in Maine was 44 km^2, and 83 km^2 for adult males (Arthur 1987). The median home range size may be a more useful measure than mean home range size, because of this variability (Arthur 1987). Males have larger home ranges and their movements are greater than for females (all cited studies). Consistent with the general pattern for Mustelidae, spatial organization in fishers appears to be intrasexual territoriality, where the range of one male overlaps that of more than one female, and home ranges within adult sexes are generally exclusive (Powell 1979). Kelly (1977) reported that fishers did not have exclusive yearly home ranges, but his data were not representative. Arthur observed one instance each of home range overlap between adult females, and between adult males, but only when 100% home ranges were considered. In all areas of intensive use, home ranges within adult sexes did not overlap (Arthur 1987).

Home ranges of juveniles appear to be larger than those of adults, however results are few (Table 12). Extensive movements of juvenile males were observed by Leonard (1980) and Johnson (1984). Johnson's (1984) estimate for the February to August home range size of a juvenile male was 41.2 km^2. A juvenile male in Manitoba moved at least 60 km in 27 days (Leonard 1980). Because juveniles disperse in the fall (Coulter 1966; Powell 1982; Douglas and Strickland 1987), juvenile home ranges are probably temporary. Adult males may influence the dispersal of juvenile males, however information is lacking. Similar to mink (Gerell 1970), ermine (Erlinge 1977), and wolverines (Magoun 1955), juvenile females may establish home ranges near the natal area.

Seasonal Home Ranges.-- Female home ranges apparently are stable throughout the year (Kelly 1977; Arthur 1987) and changes during the breeding season in home range size have not been observed. A female in Manitoba maximized the use of her former home range while denning and differences in home range size before and after having young were few (Leonard 1980). She did not increase her movements with increasing size of kits although she spent longer periods away from the den (Leonard 1980). Johnson (1984) reported that the April home range size for an adult female was smaller than February and March ranges. He hypothesized that females may constrict their home range when kits are born, contrary to Leonard's results. The smaller home range may have also been a function of the increased diversity and abundance of prey during spring.

Adult males abandon their home ranges during the breeding season, February to April, (deVos 1952; Coulter 1966; Kelly 1977; Buck *et al.* 1979; Johnson 1984; Arthur 1987), in search of females in estrus. They trespass in the home ranges of other males and extensive overlap in home range size occurs at this time. Locations obtained in March and April influence the size of home ranges (Johnson 1984) and accurate yearly ranges may be best calculated by not including this period. Arthur (1988) used locations obtained from May to December, because "home ranges appeared to be stable in size and in location".

Home ranges of fishers in New Hampshire were below average in size during January and February, they increased in size from April to June, and sharply decreased in size from July to September (Kelly 1977). Kelly hypothesized that the decrease was attributable to an increase in food abundance and temperatures. Home ranges increased in size again in December (Kelly 1977). In Wisconsin, home ranges were small during January, because of severe weather. Fishers will den up for several days during snow storms and severe weather (deVos 1952; Coulter 1966; Powell 1982).

Movements.-- Large rivers were barriers to movements of fishers in Maine (Coulter 1966) and New Hampshire (Kelly 1977). Seton (1926), however, wrote that fishers swam and deVos (1952) reported them crossing rivers and lakes. Movements of fishers were affected by deep snow in Ontario (deVos 1952), Manitoba (Leonard 1980; Raine 1981), and in Wisconsin (Johnson 1984) (Section 2.3.3). Adult males moved greater daily distances than all other age groups (Kelly 1977; Johnson 1984). Straight line daily distances ranged from 0.8 to 2.8 km for males (Kelly 1977; Buck *et al.* 1979; Raine 1981), and from 0.5 to 2.5 km for females (Kelly 1977; Raine 1981; Johnson 1984). These estimates are not representative of the actual ground covered. deVos (1952) documented a movement of 97 km in 3 days by a fisher and Quick (1953) reported that fishers may travel 13-16 km in one trip. In Michigan, daily movements (on-the-ground) averaged 5 km (Powell 1977).

In Maine, movements of fishers, predominately males, increased during March, because of breeding activity (Coulter 1966). Movements of males in New Hampshire were greatest during February, and both sexes made similar movements during March and April (Kelly 1977). The fall movements of an adult female ($\tilde{x}$ = 1.7 km, n = 30) exceeded her movements during the breeding season ($\tilde{x}$ = 1.0 km, n = 86) (Johnson 1984). The mobility of a female with kits was restricted in Wisconsin (Johnson 1984) but not in Manitoba (Leonard 1980).

Daily Activity Patterns.-- Fishers are active during both day and night (Grinnell *et al.* 1937; deVos 1952; Hamilton and Cook 1955; Coulter 1966; Powell 1977; Pittaway 1978). Most locations in New Hampshire were obtained between 0700 and 1459 hours and fishers were active on 74% of these locations (Kelly 1977). Activity increased with the proximity to sunrise and sunset, regardless of the time of year (Kelly 1977). Fishers in Michigan had a small number of activity periods (1-3) throughout the day, lasting 2-5 hours (Powell 1977). Peak activity at an artificial feeder in Ontario occurred at late afternoon and continued through the night to 1 hour after sunrise (Pittaway 1978). Two daily activity peaks were recorded for fishers in Wisconsin, between 0400 - 0759 hours, and 1900 - 2359 hours (Johnson 1984). After large meals (such as may be obtained at an ungulate kill site), fishers may be inactive for up to 48 hours (Coulter 1966). Fishers also denned up during extreme cold and snow storms (Coulter 1966; Powell 1982).

2.3.5. Reestablishment and population dispersal

The curtailment of trapping and the reintroduction of fishers was instrumental in the reestablishment of fishers in several provinces and states (Table 13). Extensive porcupine damage to forests and plantations in areas where fishers were extirpated provided an added economic incentive to attempt transplants. Since 1985, the British Columbia Ministry of Forests has sporadically attempted to introduce fishers into the forests of the Prince Rupert Region, for the control of porcupine in plantations (pers. comm., W. Jackson, Ministry of Forests).

Table 13. Reintroductions of fishers.

Year(s)	To:	From (*n*):	Cited in:
1960	Oregon	B.C. (24)	Kebbe 1961, Morse 1961, Yocum and McCollum 1973
1962	Idaho	B.C. (11)	Morse 1961, Williams 1962
1959-60	Montana	B.C. (36)	Williams 1962, Irvine *et al.* 1964, Weckworth and Wright 1968
1956-63	Ontario (Algonquin)	Ont. (97)	Strickland and Douglas 1981, Douglas and Strickland 1987
1969	West Virginia	N.H. (23)	Pack and Cromer 1981
1976	New York (Catskills)	northern N.Y.	Brown and Parsons 1983
1979-82	Ontario (Manitoulin Is. & Bruce Penin.)	Ont.	*in* Douglas and Strickland 1987
1956-66	Wisconsin Michigan	N.Y. (60) N.Y. (61)	Bradle 1957, Irvine *et al.* 1964, Olson 1966, Brander and Books 1973, Powell 1976, 1977
1966-68	New Brunswick	(25)	Dilworth 1975
1947-48 1963-68	Nova Scotia Nova Scotia	ranch (12) Maine (80)	Benson 1959 Dodds and Martell 1971

In general, reintroductions have been successful. The distances that fishers have been recovered from release points not only indicate a potential to travel large distances, but suggest that rates of dispersal differ between areas (Table 14). Fishers were restored to most of their former range in 20 years in Wisconsin, although at that time fishers still occurred at low densities in some habitats (Petersen *et al.* 1975). The increase and colonization of habitats by fishers in Maine was documented by Coulter (1960). Protection from trapping and the presence of a reserve population

Table 14. Distances transplanted fishers were recovered from release points.

Location	Distance moved[a] (km)	Time	Source
Wisconsin	48		Irvine *et al.*
	64-104 (6 M)		1964
	16	1 month	
	34	31 months	
Wisconsin and Michigan	80-96		Olson 1966
West Virginia	3 (mean)	year 1	Pack and Cromer
	4 (max)	year 1	1981
	22-44 (means)	subsequent	
	42-90 (max)	years	
Montana	55-56 (F)		Weckworth and
	72 (M, min)		Wright 1968
	102 (M, max)		
Nova Scotia	40 ("young")	8-9 years	Irvine *et al.* 1964
New York	136 (1 M)[b]	10 months	Brown and
	163 (1 M)[b]	11 months	Parsons 1983
	4-28 (2 F)		
	36-38 (2 M)		

[a] Mean, maximum, or minimum distance indicated if available; N, sex and age provided if known, M = male, F = female.

[b] Previously captive male.

were the most important factors responsible for the increase; fishers were not transplanted (Coulter 1960). Trapping seasons were closed in 1937 and reopened in 1950, a reestablishment period of only 13 years. In the next 3 years, fishers expanded their range another 14 040 km^2, at a rate of 4680 km^2 per year. In the next 7 years, the fisher range of 20 800 km^2 expanded to 36 800 km^2, a rate of 2400 km^2 per year.

Increases in Maine originated from the Moosehead Plateau, an area with numerous mountains 1200-1500 m in elevation, lack of settlement, and a vast spruce-fir-northern hardwood forest (Coulter 1966). Fishers were never extirpated from this region. Although there was no clear relationship between the rate of penetration and major forest types, dispersal was most rapid in hilly country, regardless of the forest cover present. Areas of low-lying forest containing a high proportion of bog or generally soggy area, even if densely forested, were not invaded rapidly.

Recolonization of the northern regions of Maine was gradual while dispersal in the southern range was rapid (Coulter 1966). Based on capture records, fishers dispersed 14 km/year in southwest and southcentral Maine, and 8 km/year in northeast Maine. No clear differences in habitat quality between the regions existed except that southern ranges contained a greater proportion of deciduous forests (Coulter 1966). Fishers occur at lower densities in northern Maine, possibly because they are less numerous in areas with deep snow levels (S. Arthur, pers. comm.).

A reserve population in a wildlife refuge was important for the reestablishment of fishers in Ontario (deVos 1952). Fishers from the established population dispersed into the surrounding areas where fishers had been extirpated. Habitats colonized first were comprised of a greater percentage of mature forests, were closer to climax, and had a greater percentage in coniferous trees. The overflow originated from the preserve and not from residual pockets of fisher. However, these pockets may have enhanced the rate of colonization (deVos 1951).

Technical Considerations.-- Successful reintroductions not only depend on the presence of suitable habitats, but also are a function of project design. Petersen *et al.* (1975) documented the differences between restocking attempts in two Wisconsin National Forests, Chequamegon and Nicolet. Fishers had a higher rate of colonization in Chequamegon, although habitats in the Nicolet appeared to be more suitable. Differences were a short, intensive period (11 months) for transplants in Chequamegon, versus 7 years in Nicolet, a 1:1 (M:F) sex ratio in transplanted fishers versus a 3:2 sex ratio for Nicolet, and larger sample sizes. In Chequamegon, 29 and 31 fishers were transplanted in two periods; in Nicolet, yearly transfers were 3-7 fishers, with one transfer of 26.

a. Livetrapping and handling.-- Irvine *et al.* (1964) stated that the most successful trapping of fishers occurs in March. In Maine, Arthur (1988) documented two peaks of trapping success of fishers, during October and March. Douglas and Strickland (1987) recommended trapping in late winter as females are near term and more likely to den in the new area once transplanted. Care must be taken not to trap fishers too close to parturition dates (late March to early April), or when females are lactating. This is also an important consideration if fishers are part of research and will not be transplanted. Trapping and handling during mid-April may have caused two females in Maine to abandon their natal dens (Arthur 1988).

In Ontario, trap sites were prebaited with beaver carcasses and road killed deer for several weeks prior to trapping (Douglas and Strickland 1987). A variety of bait types have been successful in

trapping fishers, including cat food and strawberry jam (Buck *et al.* 1979), duck, grouse, snowshoe hare, fish (Leonard 1980) and a lure, either commercial or oil of anise (Douglas and Strickland 1987). Traps are usually placed in cubby type locations and covered with boughs. Arthur (1988) had the highest trapping success (1.94 fishers / 10 trapnights) with traps that were equipped with radio monitors. These were modified radio collars with the magnet connected to the door and trigger with fishing line. Once a fisher was trapped, it would detach the magnet and activate the transmitter. To prevent losses of fishers due to radio failure, switches were modified to turn off transmitters when fishers were captured. Radio-equipped traps minimized human disturbance at trap sites, simplified trap monitoring, and permitted a greater trapping effort.

A holding cone, such as is commonly used to handle marten, was used to constrain fishers in Ontario (Douglas and Strickland 1987). Kelly (1977) used a wire mesh cage with a moveable side that held the fisher at the opposite door, where it was immobilized. Both methods appear to be effective and inflict a minimum of stress. Because fishers will bite at the trap, transfer cages must be designed to reduce injury. For transferring fishers, Kelly (1977) used metal lined, wooden boxes 25.4 x 30.5 x 76.2 cm in dimensions, with a metal drop-door on one end, a hinged top, and 40 holes (0.64 cm) drilled in each end. It was impossible for fishers transported in this box to injure themselves. Fishers were usually ear tagged and tattooed in one ear. Irvine *et al.* (1964) kept fishers in captivity for several days but noted that they may be kept for several weeks if fed, watered, and subjected to a minimum of disturbance. Fishers in Ontario were fed canned and commercial dog food while in captivity (Douglas and Strickland 1987).

Habitats selected for transplants in Michigan and Wisconsin had suitable cover types, no trapping, and few marten, to minimize possible competition (Irvine *et al.* 1964). As a means of monitoring movements, bait stations were placed within 10 km of release points (Irvine *et al.* 1964).

b. Immobilization.-- Ketamine hydrochloride (Ketaset, Ketalar, Ketamine), alone or in drug mixtures, has been commonly used to immobilize fishers (Table 15). Phencyclidine hydrochloride (Sernylan) is no longer available as an immobilizing agent. Fishers tolerate ketamine well but have shorter induction times and better muscle relaxation with the addition of a tranquillizer (Seal and Kreeger 1987). These authors recommend dosages of ketamine (15 mg/kg) with promazine hydrochloride (2 mg/kg), xylazine hydrochloride (Rompun) (0.5 mg/kg), or diazepam (0.4 mg/kg). A supplement of ketamine alone (5-10 mg/kg) may be used to maintain or deepen anaesthesia (Seal and Kreeger 1987). Douglas and Strickland (1987) also injected fishers with 25 mg/kg tetracycline. As well as having antibiotic properties, tetracycline is a biomarking agent. It produces deposits at active mineralizing sites in calciferous tissues and fluoresces bright yellow under ultra-violet light (Johnston and Watt 1981). Deposits remain in the dentine and cementum for life (Johnston and Watt 1981) and provide a means of monitoring cementum deposition.

Table 15. Drug mixtures and dosages used to immobilize fishers.

Drugs	Dosages (mg/kg)	Source
ketamine HCl	20-60	Arthur 1988*a*
ketamine HCl atropine sulphate	11.0 0.1	Douglas and Strickland 1987
ketamine HCl acepromazine maleate	15-20 2.5	Raine 1981
fentanyl citrate-droperidol atropine sulphate		Leonard 1980
ketamine HCl acepromazine maleate	22.0 2.5	Kelly 1977
phencyclidine HCl promazine HCl	1.0 1.0	Seal *et al.* 1970

2.4. POPULATION DYNAMICS

2.4.1. Harvests

Sex and age ratios.-- A female bias, specifically in adults, appears to be a characteristic of fisher harvests. Female biases have been reported for harvests in British Columbia (Quick 1953), Maine (Coulter 1966), New Hampshire (Kelly 1977), Massachusetts (Cordoza 1979), New York (*in* Douglas and Strickland 1979), Minnesota (Kuehn and Berg 1979), Manitoba (Leonard 1980), and Ontario (Douglas and Strickland 1987). deVos (1952) and Hamilton and Cook (1955) suggested that sex-specific harvesting may have contributed to the decline in fisher populations. However, no sex differences with respect to trap size or trapping effort were apparent in Kelly's (1977) intensive live-trapping area. It is not possible to select for female fishers by trap placement or trap size (M. Green, A. Rae, B.C. Trappers' Association, pers. comm.) and overlap in foot and track sizes precludes using this characteristic to distinguish between sexes (Coulter 1966; Johnson 1984).

Observed harvests are a function of the vulnerability of fishers to being trapped, their abundance, and the effort expended by trappers. Behavioural data suggest that males are more vulnerable because of their greater movements and larger home ranges. This increased vulnerability is especially apparent during February and March, because of the increased movements and activity of breeding (Coulter 1966; Kelly 1977; Arthur 1987; Douglas and Strickland 1987, Figs. 9, 10). In lightly trapped populations, harvests will reflect this vulnerability and males should predominate.

In Maine, when trapping seasons were closed and fishers were only trapped incidentally, the sex ratio in a sample of 56 fishers was 31 males : 25 females (Coulter 1966). With heavy harvesting, the harvest will begin to reflect the actual population sex ratio. During the regular trapping season in Maine, November to January, the sex ratio of 232 fishers was heavily biased to females (1 M : 1.73 F) (Coulter 1966). The typical female bias in harvests implies that few fisher populations are harvested lightly.

Because of their greater abundance and movements, juveniles typically comprise the largest segment of the harvest. In Ontario, the juvenile harvest was high all year, from an average of 71% in November and decreasing to 54% in February (Douglas and Strickland 1987, Fig. 10). The sex ratio at birth appears to be 1:1 although verification is required (Douglas and Strickland 1987). The 0.5 age class in harvests in Ontario has a 1:1 sex ratio (Douglas and Strickland 1987, Fig. 11), suggesting that juvenile sexes are equally vulnerable. Coulter (1966), however, reported a juvenile sex ratio of 1 male : 2.12 females (n = 87) in Maine.

Although the frequency of a biased sex ratio in juveniles is unknown, the female bias is always evident in the adult segment of the harvest (Fig. 11), implying that adult females outnumber adult males in the population. When populations in Ontario were being over-harvested, barren females appeared in harvests (Douglas and Strickland 1987), but only during years when the adult sex ratio was >2 females : 1 male, suggesting that males were too few to impregnate all females (Douglas and Strickland 1987). Once the harvest was decreased by shortening the trapping season and reducing quotas, barren females disappeared from samples (Douglas and Strickland 1987).

Old males typically are rarer than old females in harvests. In Minnesota, only one male was older than 4.5 years, while 11 females were 5.5 -10.5-years-old (Kuehn and Berg 1979). In Ontario, the percentage of females 3.5 to 10.5-years-old exceeded the percentage of males, for every age (Fig. 9, Douglas and Strickland 1987). From evidence of intraspecific aggression (pelt scarring in males, Section 2.3.2), Douglas and Strickland (1987) hypothesized that juvenile males faced an added mortality factor from adult males, significantly reducing the proportion of males in the population.

Radio-collared fishers have provided insight into age-specific vulnerability patterns. In Maine, the mortality of juveniles of both sexes was 59% (10/17), and adult females had the least (2/13) (Arthur 1987). The vulnerability of adult males was similar to that of juveniles (S. Arthur, pers. comm.). The stability of female home ranges (Section 2.3.4) greatly contributes to their low trapping vulnerability. Males, however, demonstrate frequent shifts in home ranges, particularly during the breeding season (Section 2.3.4). The biased adult sex ratio may be a result of a higher natural mortality for juvenile males, or the low vulnerability of adult females, or a combination of both factors.

Utility of Age and Sex Ratios in Management.-- Douglas and Strickland (1987) proposed an indicator of trapping intensity as the ratio of juveniles : females ≥2.5 years old. The ratio is analogous to kits per female and can be related to corpora lutea counts (the following examples are cited in Douglas and Strickland 1987). An expected ratio in Ontario, if harvests reflected population age ratios and accounting for reproduction and natural mortality, was <3.0:1. When harvesting was light, fewer adult females were harvested, and the ratio was biased to juveniles (18:1 with low quotas). When the harvest (and presumably the population) was stable, the ratio was 5:1 - 7:1. These ratios are specific for the Algonquin region in Ontario and reflect fecundity,

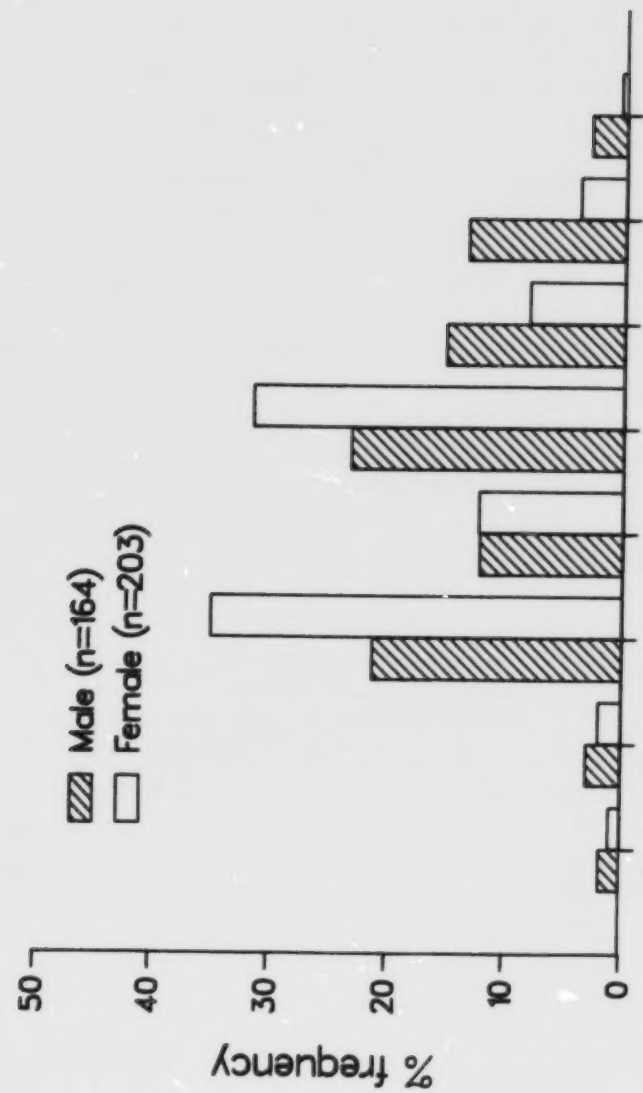

Figure 9. Frequencies of sexes of fishers in monthly harvests (September to April) in Maine during 1950-1965 (Coulter 1966).

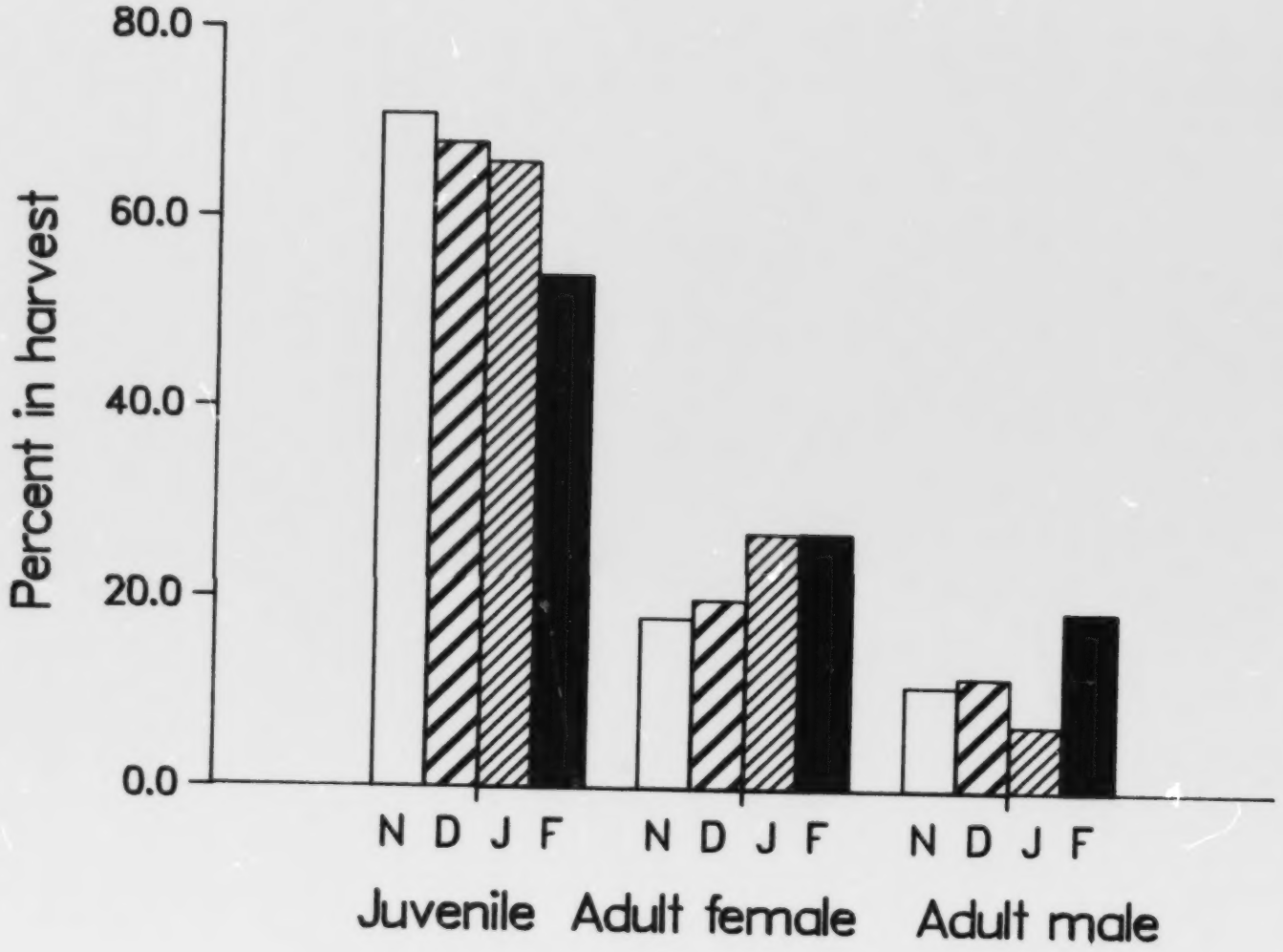

Figure 10. Distribution of fisher sex and age classes (juvenile includes both sexes <12 mos.; adult: >18 mos.) harvested from November to February 1972-73 to 1983-84, in the Algonquin Region of Ontario (Table 12 in Douglas and Strickland 1987).

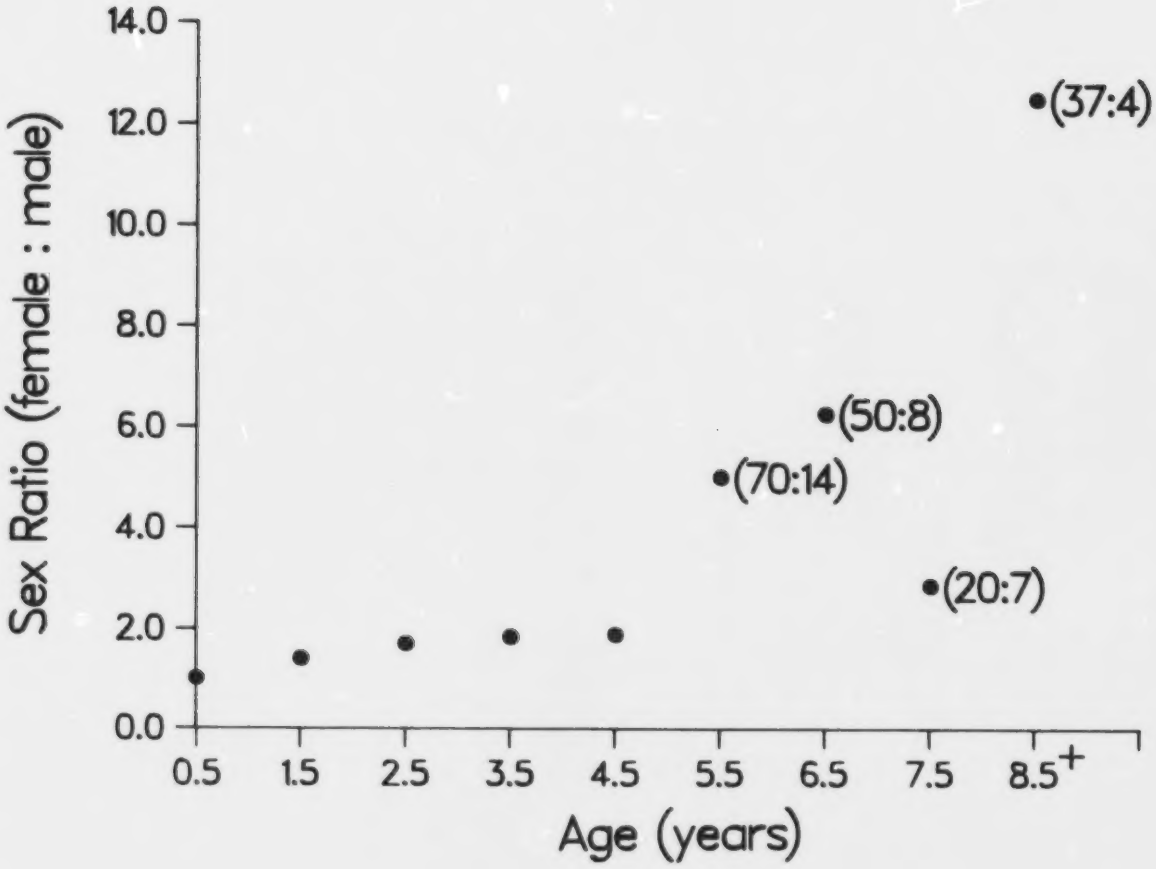

Figure 11. Sex ratios in age classes of the fisher harvest in the Algonquin Region of Ontario from 1972-73 to 1983-84 (Table 13 in Douglas and Strickland 1987).

densities, and habitat productivity. In Minnesota, a ratio of <7:1 represented declining populations, likely because of a lower fecundity (a mean of 2.2 corpora lutea) (*in* Douglas and Strickland 1987). In New York, populations declined when the ratio was <6:1 (M. Brown *in* Douglas and Strickland 1987).

Ultimately, trial and error will determine what ratios are appropriate. However, population models have provided reasonable simulations of fisher populations (Douglas and Strickland 1987) and may be used to suggest suitable choices, if estimates of natality and harvests are available. The proposed indicator is easily determined, if a representative sample of the harvest is available. Cementum analysis may be used to determine females ≥2.5 years old. Radiographs are a relatively quick method of distinguishing between juveniles and adults (Section 2.2.2) and an alternative ratio, juveniles : females ≥1.5 years in age, may also be used as an indicator of trapping intensity. A ratio >3 represented a safe harvest level in the Algonquin Region of Ontario (Douglas and Strickland 1987).

2.4.2. The fisher population

Population Composition and Densities.-- Little is known about the composition of fisher populations, such as what proportion is comprised of transients and the stability of spatial systems over time. Arthur (1987) has monitored the largest number of individuals within a fisher population. He reported no transients in his study, however intensive trapping removed a large proportion of juveniles and continually created open home ranges (S. Arthur, pers. comm.). Arthur (pers. comm.) also found constancy in female home ranges. Two collared females maintained the same home ranges for 4 years. Males, however, demonstrated considerable shifting of home ranges, especially during breeding. Thus, the transient segment in fisher populations is most likely male.

Densities estimated for regions in eastern North America were relatively high, ranging from one fisher / 0.6 km^2 to 1 / 18.9 km^2 (Table 16). Arthur (1987) suggested that fishers were better adapted to deciduous and transitional habitats rather than northern coniferous forests. These habitats support the highest densities of fishers in North America. The estimates from western regions, British Columbia and California, are >1/200 km^2 (Table 16). Because of exclusive home ranges within adult sexes, densities are a function of home range size. Harvest densities indicate that productivity in the west is low (Section 2.1.2). However, the maximum home range size estimated for a fisher is 80 km^2, with mean home range sizes ranging from 15 km^2 to 80 km^2 (Section 2.3). Estimates for western regions either include unoccupied habitats or are inaccurate.

An estimate of population size is necessary to calculate what proportion of the population is being harvested, and to determine allowable harvests. A harvest rate of 1 fisher/25.9 km^2 in Ontario represented an annual harvest of 20-25% and provided stability (Douglas and Strickland 1987). Some areas in Ontario have sustained harvests as high as 1 fisher/13 km^2 with no decline in populations (M. Strickland, pers. comm.). The rate of harvesting at which populations start to decline is a function of habitat productivity and natality. Recent harvest densities in productive habitats in Maine were a mean (among counties) of 1/15 km^2, and a maximum of 1/6.7 km^2 (Arthur 1987), and these apparently were not overharvests. Powell (1982) simulated the dynamics of fishers and their prey under different harvest regimes and determined that only small increases in harvest mortality could cause local extinctions. Although his results are specific to the Ottawa National Forest in Michigan, they indicate that fishers are readily susceptible to overharvesting.

Table 16. Estimated densities of fisher populations.

Density (1/km²)	Location	Method of calculation	Source
1/10-12[a]	Maine	harvests	Coulter 1960
1/2.6[b]	Maine	harvests, snow tracking	Coulter 1966
1/2.8 - 1/10.5[c] 1/8.3 - 1/20.0[d]	Maine	home range size & natality ests.	Arthur 1987
1/0.6-1/10	New York		Hamilton and Cook 1955
1/6.5[e]	Ontario	harvests	Douglas and Strickland 1987
1/18.9	Wisconsin	radio-telemetry	Johnson 1984
1/208 (pre-trapping)	British Columbia	harvests, snow tracking	Quick 1953
1/206[f]	California	observations, harvests	Grinnell *et al.* 1937

[a] in good habitats.
[b] in some areas, temporary density during recolonization.
[c] pre-trapping.
[d] winter.
[e] pre-trapping, assuming harvest is 25% of pre-trapping density.
[f] "doubtful" if density is this "high" (Grinnell *et al.* 1937).

Natural Mortality and Natality Rates.-- In harvested populations, most mortality in winter is likely from trapping. Although data on age-specific natural mortality rates are lacking, the factors which contribute to age-specific trapping vulnerability likely also contribute to natural mortality, at least in winter. As input into a population model, Douglas and Strickland (1987) predicted summer natural mortalities of 30% for juveniles and 10% for adults and obtained reasonable results. On commercial mink and fox ranches, the expected mortality from whelping to pelting (i.e., the juvenile age class) is 18-25% (Addison *et al.* 1987). Considering that fur ranches attempt to maintain optimal conditions, natural juvenile mortality rates will be at least as high and probably higher.

Population natality rates can be quantified with less error than mortality rates, using corpora lutea counts. If a carcass sample is representative of the harvest age distribution and a harvest is representative of the age distribution of the population, the estimated natality will reflect the population natality. More information is required on the denning rate, the proportion of adult females that whelp young, and on the size of wild litters. Natality may be overestimated if losses in the wild are not accounted.

2.4.3. Interspecific relationships

Fisher and Porcupine.-- Both porcupine and fishers are endemic to North America and archaeological evidence suggests that the two species evolved together (Parmalee and Oesch 1972; Powell and Brander 1977). Because the fisher is efficient at killing porcupines, it has been introduced as a biological control agent (Section 2.3.5). Notable declines in porcupines in some areas of the Adirondacks were concurrent with increases in fishers (Hamilton and Cook 1955). Porcupine populations in Wisconsin and Michigan forests declined after the reintroductions of fishers (Olson 1966). With the reintroduction of fishers in the Algonquin Region of Ontario, fishers did not eliminate porcupine but populations decreased in size as evident from a reduction in tree damage and in the numbers of road killed porcupine (Douglas and Strickland 1987). Earle (1978) compared porcupine densities in an area with an established fisher population to porcupine densities in an area where fishers were absent or rare. Porcupine were less numerous within the established range of fishers. However, Earle (1978) concluded that a 3-year study was insufficient to determine if fishers controlled porcupine.

Powell and Brander (1977) investigated the significance of fisher-porcupine interactions in Michigan. The porcupine population on a 178-ha study area declined 76% during the 13 years of fisher reestablishment. It appeared that a dynamic stability was reached at porcupine densities of 9-10/256 ha, or 1/25.6 ha. They suggested that the fisher-porcupine relationship was self regulating, with fishers switching between porcupine and snowshoe hares (Powell and Brander 1977).

All evidence indicates that fishers have an impact on porcupine populations. The size of this impact is dependent on fisher density (a function of habitat productivity), possibly the age distribution of the porcupine population, and the availability of other prey. A porcupine population with a large percentage of older individuals may be more resistant to attack as large porcupine are more able to repel attacks by fishers (Powell and Brander 1977; Earle 1978, Section 2.3.2). The importance of porcupine in the diet is dependent on the availability of other prey. Considering that porcupine have a high handling time (Powell 1982), fishers may not have as large an impact on porcupine populations if alternative prey of higher value are available.

Population Cycles.-- Hewitt (1921) reported that fisher numbers fluctuated periodically but that the cycles had a small amplitude because of the species' low densities. Cowan (1938) concluded that fishers did not display the pronounced fluctuations seen in other, more specialized species because of a diverse diet. Population cycles of fishers in Canada and British Columbia were described as regular, with a mean period of 9.7 years (Hewitt 1921; Cowan 1938). Hewitt (1921) noted that fisher cycles were independent of snowshoe hare cycles, contrary to results for marten. Cowan, however, stated that fishers displayed a lag from the hare cycle because of the availability of other food sources "It takes from 2 to 4 years for the fisher to deplete the other available food sources, and the effect of the rabbit depression is ... deferred rather than immediate..." (Cowan 1938).

Butler (1953) reported that the "good years" for fisher were closely connected to those for snowshoe hare but fishers appeared to respond more slowly than other species. This was attributed to the lag in reproduction because of delayed implantation. Fisher did not cycle during 1751 to 1847 but did from 1920 to 1969 (Bulmer 1975). Breaks in cyclicity were attributed to habitat disturbances and increasing trapping pressure (Butler 1953; Bulmer 1975).

Keith (1963: 54) reported that evidence of a fisher cycle in British Columbia was completely lacking. However, he demonstrated the presence of synchronous cycles for coyote, fishers, and red foxes, in Manitoba during 1932-1960 (Keith 1963). Although comparative data are few, fishers in Manitoba relied more heavily on snowshoe hare (Leonard 1980; Raine 1981) than did fishers in other areas, possibly indicating a greater tie with the hare cycle.

Most of the prey of fishers display fluctuations in population size. Microtines commonly have 3-4 years between population highs, and hares and grouse demonstrate a 9-10 year cycle (Keith 1963). As stated by R. McCabe (*in* Keith 1963: vii), "to deny biological cycles because they cannot be characterized .. precisely is to be .. unrealistic". Fishers are affected by the periodic abundances of their prey but effects on population size are not predictable. Functional responses with changes in the availability of snowshoe hare and carrion have been observed. However, because fishers have diverse diets, low litter sizes, and are not tied to one specific type of habitat, numerical responses likely do not occur or are not readily apparent.

Fishers and Marten.-- Clem (1977*b*) and Raine (1981) have suggested that competitive interactions between fishers and marten may be an important factor controlling distributions and population levels. Trappers have often noted that fishers and marten do not occur in the same area (deVos 1952; G. Rae, B. C. Trappers' Association, pers. comm.). The range of marten in North America is greater than that of fishers. Martens extend further north, and their distribution includes Alaska and the coastal islands.

Harvest maps in Ontario suggest an inverse relationship between fishers and marten (Douglas and Strickland 1987). Fishers may occupy lower elevations than do marten (Dalquest 1948; Ingles 1965). Rand (1944) stated that fishers preferred lower and wetter forest country. deVos (1951) observed that fishers were better adapted to earlier successional stages than marten. In Maine, forests in climax stages predominately supported marten. After logging, fishers became prominent. As the forest matured, evidence of marten increased. This cycle was evident over a relatively short period of 113 years (*in* Douglas and Strickland 1977: 34). Coulter (1960) suggested that the slower recovery of marten in Maine, relative to fishers, was attributable to a lower potential rate of reproduction. The difference in recovery rates, however, may have been because habitats were more suited to fisher dispersal.

Clem (1977*b*) assessed competition between fishers and marten by comparing diets and habitat selection. He hypothesized that competition may only exist during certain seasons such as winter when the variety and abundance of food and appropriate cover may be in short supply. Diets of the two species were similar only from December to February and he concluded that competition was insignificant because of its short duration (Clem 1977*b*). Rosenzweig (1966) suggested that differences in body size would constrain marten and fisher to different sized prey. Marten in Manitoba ate more smaller prey than did fishers, although both species ate snowshoe hares during

a population high (Raine 1981). Diets described for other areas have been similar (Clem 1977*b*) and habitat partitioning because of body size differences appears to be more important than differences in diets. Marten in Manitoba were more arboreal, engaged in more subniveal hunting in winter, and were less restricted by snow cover than were fishers. Marten may be more constricted than fishers with respect to suitable resting sites in winter (Buskirk 1984).

2.5. MANAGEMENT

2.5.1. Population

Economically, the contribution of fishers to British Columbia's furbearer harvest has not been large. In this decade, yearly harvests range from 325 to 941 fishers, despite a relatively high pelt value. Low harvests are likely a function of the species' rarity, and not due to low trapper interest. In actuality, the increasing pelt value suggests a concurrent increase in demand and in trapper effort. For only a small number of trappers, however, will fisher harvests represent an important source of income.

Because of their wide ranging movements and large home ranges, responsibility for ensuring adequate numbers of fishers cannot be relegated to the individual trapper. The fisher is designated as a Class 2 species, "those furbearers not present on registered traplines in manageable numbers, and which are vulnerable to overharvest". Trapping seasons currently in effect are applied at the level of the administrative region. However, such a unit of area is large, contains diverse habitats, and is inappropriate for management of fishers. Conversely, the "management unit" (MU) is too small and also inappropriate. The best strategy is to consider management of fishers at the habitat level, the ecoregion or ecosection.

Population Status and Population Size.-- Samples of carcasses and harvest data may provide estimates of the harvest sex and age composition, the number harvested, and natality. However, trends observed in the harvest rarely mirror those observed in the population. Harvest composition is not only a function of the abundance of animals, but is also determined by trapper effort and the differential vulnerability of sex and age classes to being trapped. Estimates of population size and age-specific survival rates must be obtained independently from harvest data.

Reductions in populations, in historical distributions, and theoretical investigations indicate that fishers are susceptible to overharvesting. The rate at which overharvesting occurs is habitat and population specific. Techniques such as track censuses may be used to index population status but field survey methods are labour and cost intensive and not likely to be useful to monitor populations on a long term basis. Trappers, however, continually monitor animal sign (tracks, scats, kills) year after year. Information regarding the population status (whether the population is increasing, decreasing, or stable) of fishers and their prey may be provided by trappers through the use of questionnaires and interviews.

The most accurate means of determining population size is by following animals outfitted with radio transmitters. Although this method is costly, studies can have wide applications. Density estimates obtained in one area may be extrapolated to other areas containing similar habitats. Radio-telemetry studies also allow the collection of habitat use information.

Harvest Composition.-- The use of harvest sex and age ratios to monitor trapping intensity was successful in Ontario and provides a template for assessing harvest effort in British Columbia. Monitoring is not likely to be necessary for all of the province but only for fisher populations that are being intensively trapped. Carcass samples which are representative of the harvest within habitat units (e.g., ecoregion) are required. Once such populations are identified, however, the harvest intensity and harvest limits need to be determined yearly. Radiographs of lower canines (from the skull or lower jaw) provide a cost effective method of determining sex and age for large samples.

Productivity of fisher populations is relatively low and the occurrence of barren females may be a function of nutrition and habitat productivity. Natality estimates for British Columbia fishers are required and may be obtained from carcass samples. Denning rates are not available but best guesses may be provided considering habitat productivities, densities, and in comparison with results for more productive habitats in eastern North America.

2.5.2. Habitat

An essential component off fisher habitat use appears to be habitat diversity. The best habitats are multi-aged stands interspersed with openings and containing wetland or riparian habitats. The impacts of clearcut logging on fisher may be decreased by limiting the size of clearcuts, encouraging irregularly shaped cuts, maintaining forested cover on ridgelines and drainage bottoms, and retaining and encouraging ground cover in cutovers to provide for the prey of fishers (Allen 1983). Allen (1983) also recommended that old snags and hollow trees be maintained for den sites. As habitat diversity is a critical habitat requirement for fishers, uneven-aged forest management will generally favour fisher habitat quality (Allen 1983). Even-aged forest management with small clearcuts or rotation of sufficient length to maintain most of the forest in mature age classes is an alternative practice (Allen 1983). Although evidence indicates that fishers will use clearcuts, at least during summer, the size and shape of cuts will determine the intensity of use. Smaller clearcuts in various shapes will affect fisher habitat less than cuts that are large and rectangular.

Habitat partitioning between fishers and martens appears to occur, but habitat management for these species need not be mutually exclusive. Both fishers and martens require suitable denning sites, especially for natal dens. The activity of fishers is restricted by deep snow. Climax and old growth forests, especially in areas with deep snow levels, may have equal importance for fishers and martens by providing den sites and cover. Ecotones and riparian areas are important to fishers and their maintenance and promotion will benefit both species. Fishers prey on snowshoe hares and because hares use young seral stages for foraging, forest management which benefits snowshoe hare and lynx will also benefit fishers.

Habitat suitability index (HSI) models are a means of quantifying habitat quality and provide an objective tool for assessing the impact of forest management plans. One known example of an HSI model (Allen 1980) was tested for fishers in Michigan with encouraging results (Thomasma 1988). Foresters often lack the information necessary to assess habitat suitability for wildlife, especially for mustelids which are secretive and use habitats in ways that are not readily apparent. An HSI model is one means of transferring this information.

2.5.3. Management options

An assessment of habitat capability for fishers in British Columbia is a first step in the management of habitats and populations. Reliable harvest records for British Columbia are available from 1985-86 (R. Archibald, pers. comm.) and in conjunction with information on trapper effort currently being collected (R. Archibald, pers. comm.), may be used to estimate the success rate or catch per unit effort (CPU), on an ecoregion or ecosection basis. If an independent estimate of density for at least one ecoregion (or ecosection) is available, relative habitat capability may be used as a scaling factor to estimate densities. Areas of concern, those ecoregions that cannot sustain a high trapping effort, can then be identified, providing a basis for management actions.

Management of fishers needs to be considered in conjunction with forest management plans. Within a timber supply area (TSA), wildlife habitat is usually considered prior to the calculation of the annual allowable cut (AAC). Areas deemed important to fishers may be identified and arguments presented for maintenance of these areas. Because of the fisher's propensity to prey on porcupine, the forest industry has an added incentive to maintain fisher habitat. Consideration of furbearers, however, in forest management plans is a relatively new concept.

Single-species management is short sighted. Habitats important to fishers are also important to other species: those dependent on old-growth (such as marten, many species of birds, ungulates in winter) and species using other seral stages (e.g., snowshoe hare, lynx). A management strategy which is truly integrated should consider the needs of all species in forest management plans, including furbearers, non-game species and ungulates. The need to maintain biodiversity should be emphasized as opposed to concentrating on the needs of a single species.

Specific options for managing fisher populations are:

1. The length and timing of trapping seasons are factors in determining the size and composition of a harvest. For all administrative regions, fisher trapping seasons extend into February, the period of reproduction for females and of increased vulnerability for males. Trapping seasons need to be reevaluated in consideration of sex and age-specific vulnerability to trapping and pelt primeness.

2. Pelt sealing is the most accurate means of monitoring harvests (Obbard *et al.* 1987) and may be considered in areas where overharvesting is a concern.

3. It may be possible to monitor harvest intensity through the use of sex and age ratios. The relationship between harvest ratios and population size, and estimates of natality are required information. Sex and age may be estimated from radiographs of canine teeth. Collection of carcasses (or reproductive tracts) will allow age-specific natality to be estimated.

4. Quotas or closed seasons may be used in areas where overharvest is suspected or identified from age ratios. Quotas have been successfully used in Ontario to limit harvests and are preferred over season closures. However, the proportion of fishers caught in traps set for other species may be high; 35% (286/817) of fishers were non-target species in Ontario and about 50% in Maine (S. Arthur, pers. comm.). The success of quotas in allowing a

population to increase will depend on this error rate and on the willingness of trappers to stay within limits. The proportion of fishers caught in traps set for other species may be determined by including this question on a trapper questionnaire.

5. Refuges, untrapped pockets or populations of fishers, should be maintained. Reserves of unlogged and untrapped wilderness have been important in the reestablishment of fisher populations. These areas not only provide a source of dispersing fishers for trapped regions but are insurance against population reductions. Trappers may be able to maintain adequately sized reserves on their traplines but the size of these areas will depend on habitat productivity.

6. Transplants may be considered if necessary but transplants into areas where the habitat appears suitable but has deep snow in winter (such as in coastal areas) may not be successful. Preliminary studies are necessary before transplants are initiated.

7. The use of simulation models may provide estimates of population parameters not currently available for fishers and can demonstrate the impacts of management actions. Input requires, at the least, reliable estimates of natality and mortality.

8. HSI models may be used to quantify fisher habitats and to predict the capability of habitats for fishers.

2.5.4. Recommendations

The following recommendations for management action and research are prioritized by: actions which will produce the necessary information in the shortest time, the relative importance of estimating unknown population parameters, and cost-effectiveness.

Priority

1. An analysis of harvests by ecoregion or ecosection. If estimates of effort are available, CPU may be used to provide estimates of habitat capability. Ecoregions of concern, those containing populations that cannot tolerate a high harvest pressure and are at danger of being overharvested, need to be identified.

1. An analysis of population status by ecoregion based on trapper provided information. As fisher populations fluctuate, several years of data regarding population status and a history of logging and other land-use practices are required.

2. Collection of female reproductive tracts to estimate natality.

2. Collection of skulls to estimate the sex and age composition of harvests and an assessment of the utility of ratios to predict harvest intensity. The date of kill should be collected with skull or carcass submissions to allow the sex and age-specific vulnerability (to being trapped) over a season to be described.

2. Re-assessment of trapping seasons, based on the above data.

3. Identification of critical habitat needs.

4. Determination of densities in representative habitats. Relative habitat capabilities may be used to estimate densities. However, an independent density estimate in at least one ecoregion is necessary.

4. Development of a population model to predict the effects of differing harvest regimes.

5. Determination of density and habitat use by radio-telemetry. The study area should be located in an ecoregion representing optimal habitat for fishers.

5. Development of HSI models to predict the capability of habitats based on information provided by Ministry of Forests inventory. A protocol for testing, refining, and validating models needs to be established.

2.6. LITERATURE CITED

These references deal with topics other than fishers and are not included in the bibliography. Two recent references (Arthur *et al.* 1989*a* and 1989*b*) were published after the bibliography was completed. The source document for these papers is Arthur (1987) (in the bibliography).

Allen, A.W. 1987. The relationship between habitat and furbearers. Pages 164-179 *in* M. Novak *et al.*, eds. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto.

Addison, E.M., I.K. Barker, and D.B. Hunter. 1987. Diseases and parasites of furbearers. Pages 893-909 *in* M. Novak *et al.*, eds. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto.

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Wright, P.L. 1950. Development of the baculum of the long-tailed weasel. Proc. of the Society for Experimental Biology and Management 75:820-822.

Wynne, K.M. 1981. Summer home range use by adult marten in Northwestern Maine. M.Sc. Thesis, University of Maine, Orono, Maine. 19pp.

PART 3: THE FISHER LITERATURE: AN ANNOTATED BIBLIOGRAPHY

3.1. INTRODUCTION

This bibliography is comprised of 175 annotated citations, including unpublished reports. The majority of research on fishers originates from eastern North America. Of Canadian research, most papers were from Ontario (31 references), and in the United States, from Maine, Michigan, New Hampshire, New York, and Wisconsin. Only one quantitative study originated from a western state, a radio-telemetry project in California (Buck *et al.* 1979). Although important, because it is the only documentation of habitat use by fishers in Douglas-fir cover types, it represents an incomplete (1 year) study.

Of the 22 references that refer to British Columbia, the main topic in eight was distribution, in four it was habitats, three reported that British Columbia was the source of fishers for transplants to other states, two reported on reproduction (one contained data from fur farms, the second was an unpublished report with limited data), two on subspecies, one on population cycles, one documented the occurrence of porcupine quills in fisher carcasses, and one was the Ministry of Environment management plan for mustelids (Munro and Jackson 1979).

The time span of papers ranges from 1898 to 1988. Frequencies were 2 (1.1%) for pre-1900, 0 for 1900-1919, 12 (6.9%) for 1920-1939, 34 (19.4%) for 1940-1959, 79 (45.1%) for 1960-1979 , and 48 (27.4%) for 1980-1988. I omitted many of the pre-1920 papers because they were largely anecdotal and did not contribute new information. Research appears to be increasing, an encouraging 5.9 papers per year were cited during the 1980's, compared to 3.9 papers per year during the previous 20 years.

A major theme of 1940-1959 papers was the decline of fisher populations, and subsequent reestablishments. The porcupine-fisher relationship was prominent in popular reports, diet studies, and accounts of reintroductions. Of the 175 papers, most (32%) fell under the single heading of distribution (n = 56). Results were often a single sighting, a review based on harvests and historical information, or archaeological findings. I emphasized reports for British Columbia and adjacent areas. Recent (1980 and later) reports on distributions in central and eastern states were included if they presented new information and evaluated the status of fishers after reestablishment. Extensive discussions of fisher distributions are in Allen (1942), Rand (1944), and Hagmeier (1956). Allen's data are biased to the United States and Rand only considers Canada. Hagmeier provides the most comprehensive report, with entries for each province and state. Major references specific to British Columbia are Edwards (1950) and Edwards and Cowan (1957) for the northern Boreal Forest, Bandy (1952) for eastern British Columbia, and MacLeod (1950) for the Coast Forest.

Most of our knowledge of fisher behaviour comes from Powell's (1977 and subsequent) research. He emphasized predator-prey interactions, including snowshoe hare and deer as well as porcupine, foraging behaviour, activity, and energetics. Although Powell radio-collared fishers, his methods were primarily snow tracking, observations, and experiments with captive animals. The first quantitative field studies did not have the benefit of radiotelemetry and relied on snow tracking: deVos (1951, 1952) in Ontario, Quick (1953) in British Columbia, and Coulter (1966) in Maine. Coulter's (1966) Ph.D. provides the first intensive examination of fisher biology.

Subsequent field studies have used radiotelemetry, Kelly (1977) in New Hampshire, Buck *et al.* (1979) in California, Leonard (1980) and Raine (1981) in Manitoba, Johnson (1984) in Wisconsin, and Arthur (1987) in Maine (all are theses except for Buck *et al.* 1979). Kelly (1977) was the pioneer, the first to use radio-telemetry and the first to document cementum analysis as an aging technique for fishers. Arthur (1987) collared the largest number of fishers (43) and provides the best description of fisher home range use and spatial behaviour. Johnson (1984) and Buck *et al.* (1979) were 1-year studies and contribute minimal information. Leonard (1980) and Raine (1981) studied fishers in boreal forest habitats, and examined the effect of snow cover on fisher behaviour.

Other theses with fisher as a central theme are Davison (1975), an evaluation of the relative value of four diets to captive females; Clem (1977*a*, *b*), a comparison of fisher and marten diets in Ontario; Leach (1977), a description and comparison of fisher and marten skeletons; Earle (1978), an examination of the fisher-porcupine relationship in Michigan; Rego (1984), an examination of harvest levels in Maine (not seen); and Thomasma (1988), the first attempt at verification of an habitat suitability index model (Allen 1983). Thomasma's study is a valuable contribution as verifications of habitat suitability index models, for any furbearer, are rare.

An important source of information are Douglas and Strickland's laboratory studies in Ontario. More than 6000 carcassess were collected over 13 years, providing the most complete data on harvest age and sex ratios, reproduction (particularly age-specific natality), and age determination. Although a number of unpublished reports are frequently cited, a comprehensive summary is in Douglas and Strickland (1987).

3.1.1. Format

References are alphabetical and each has a unique identifying number. Unpublished manuscripts are indicated as "(ms)" after the date. After each citation is a maximum of three descriptions. The first is a series of keywords in alphabetical order. The second, on a new line, and if applicable, consists of the dates when field studies were conducted or when fishers (carcass samples) were trapped. The third is a 1-2 line statement, in bold print, stating the essence or objectives of the paper. The annotation follows, consisting of methods, results, and salient points of the discussion. I have attempted to avoid judgements and where a comment was deemed necessary, it appears italicized.

3.2. THE LITERATURE

1. Allen, A.W. 1983. Habitat suitability index models: fisher. United States Fish and Wildlife Service, Biol. Services Program. FWS/OBS 82/10.45. 19pp.

cover, diets, HSI models, habitat use, reproduction, review
An extensive review of fisher habitat requirements is used to develop an habitat suitability index (HSI).

HSI MODEL: Season - year-round. The life requisite being modelled is "winter cover". If suitable winter cover is not present, the needs of fishers in other seasons will not be met. It is assumed that a minimum of 259 km^2 of potentially suitable contiguous habitat must be present before an area will be successfully inhabited by a population of fishers. Smaller forest areas are unsuitable if isolated. Variables in the model are "percent forest canopy", "average dbh of overstory", "tree canopy diversity", and "percent overstory comprised of deciduous species". *(Thomasma 1988 presents a first attempt at verification).*

2. Allen, G.M. 1942. Extinct and vanishing mammals of the Western Hemisphere. American Committee for International Wildlife Protection. No. 11: 174-181 (fisher).

Canada, distribution, habitat, United States
Distribution of fisher was determined from historical reports and locations of specimens. The emphasis is on the United States.

UNITED STATES: There are a few fisher left in northern and central Maine, northern New Hampshire, and northern Vermont. Fisher occurred in Massachusetts, but are now extinct. In Pennsylvania, fisher formerly occurred in "some numbers", especially in the beech forests of the more mountainous portions. Fishers used to occur along the mountains of West Virginia to North Carolina and Tennessee, but have long ago been extirpated from these regions. They no longer occur in Indiana. Fisher still exist in Wisconsin and Michigan but are rare in Minnesota. Historically, the range of fisher extended to northeastern North Dakota, where they apparently were fairly common. No fishers occur in the state at present. Fishers are rare in Washington. In Oregon, fishers occur in the cool, humid coast ranges and probably also in the Blue Mountains, but harvests are small. Fewer numbers are found in Montana. Reportedly, fishers in 1891 occurred in Idaho but were rare. Historically, fishers occurred in Wyoming, and there is little evidence supporting their presence in Colorado. Fisher do not occur in Alaska.

CANADA: In eastern Canada, numbers of fishers have been depleted. Fishers are extinct in Nova Scotia. Few occur in remote parts of New Brunswick, such as Gaspe. Fisher are rare in Quebec. Fishers are found in small numbers around the southern end of James Bay. In Ontario, fishers are rare in some areas and apparently abundant in others. The northern limit includes Great Slave Lake of the Northwest Territories and Liard River in Yukon. It occurs in "some numbers" in the forests of British Columbia.

3. Anderson, E. 1970. Quaternary evolution of the genus *Martes* (Carnivora, Mustelidae). Acta Zoologica Fennica. 130. 132pp.

age determination, distribution (map), marten, morphology, skull, systematics, subspecies, taxonomy

A systematic study of Pleistocene and recent *Martes*, their Quaternary history, distribution, relationships, and taxonomy.

TAXONOMY: Subspecific variation in east and west populations of fishers is not apparent.

FISHER AND MARTEN DISTRIBUTION: Ranges are similar but the fisher's northern limit is 10° south of marten. The 2 species extend equally far south in the Pacific mountains. The fisher has a more restricted range in the Rocky Mountains and a more extensive one in the East. Fisher also differ from marten in that they do not occur on the western coastal islands, in Alaska, nor in northern Canada. The fisher's southern limit in the Rocky Mountains is Yellowstone National Park.

PHYLOGENY: The genus *Martes* occurs in 3 subgenera, *Martes*, *Pekania*, and *Charronia*. *Martes pennanti* is the sole representative of the subgenus *Pekania*. It differs from the true martens by its large size and an external median rootlet on P^4 (absent in the subgenera *Martes* and *Charronia*). Fishers can be traced back to the middle Plesitocene from *M. diluviana*, and from the Chinese Pontian form, *M. palaeosinensis*. Modern fisher is known from the late Pleistocene and postglacial deposits in the U.S. The earliest known occurrence is from the late Wisconsin but fisher may have come across from China in late Illinoian or early Wisconsin times. The historical *M. diluviana* is probably not directly ancestral but is the fisher's ecological forerunner.

SKULL: "The powerful skull of *M. pennanti* is characterized by a short rostrum, long postorbital region, and expanded occipital region...As in other mustelids, the postorbital constriction decrease with age while the zygomatic breadth increases." Fisher have relatively large, robust teeth which are morphologically similar to marten. Noticeable sexual dimorphism occurs in almost all tooth measurements of fishers.

4. Anderson, R.M. 1934. The distribution, abundance, and economic importance of the game and fur-bearing mammals of western North America. Proc. Fifth Pacific Science Congress, University of Toronto Press. Vol 5:4055-4075.

Canada, distribution (map), furbearers, harvests

Major topics are distributions of species, densities, economic values, importance of the fur trade, and distributions of fur production. Formerly widely distributed in heavily forested regions, fishers never ranged as far north as marten, and their range has been reduced in the south. Over-harvesting is a primary factor behind the reduction in fisher numbers.

5. ____. 1947. Catalogue of Canadian recent mammals. National Museum of Canada, Bull. No. 102:59-60 (fisher).

Canada, subspecies, taxonomy

A report of the subspecies of fishers: *Martes pennanti pennanti*, *M. pennanti columbiania*, and *M. pennanti pacifica*. Re-examinations of subspecific classifications are cited (no original research.

6. Arthur, S.M. 1987. Ecology of fishers in southcentral Maine. Ph.D. Thesis, University of Maine, Orono. 112pp.

diets, habitat use, home range use, Maine (south-central) mortality, natal dens, radio-telemetry, resting sites
January 1984 - August 1987
The most successful of radio-telemetry studies on fishers, a relatively large number of collared fishers monitored for a long period provided reliable estimates of home range and habitat use. (This thesis not seen, information was abstracted from 2 unpublished papers written for publication).

The study area (500 km²) was in an area containing the highest fisher harvest density in Maine: a mean of 1 fisher/ 15 km² during 1979-1984. Some townships reported harvests of 1 fisher / 6.7 km². The trapping season was 5 weeks, from October to December.

HABITAT: Much of the region consisted of farmland, abandonded during 1880-1980, that had reverted to second growth. Habitats were a mixture of forest types interspersed wtih small farms and pastures. Balsam fir, hemlock, white pine, oaks, maples and birches occurred in uplands. Red spruce, black spruce, and tamarack occurred in lowlands.

HOME RANGES: Forty-three fishers were captured and radio-collared, 22 adults (≥1 year) (11 M, 11 F), and 21 juveniles (<1 year) (17 M, 4 F). Locations from May to December were used because the home ranges seemed stable in size and location. Home ranges were calculated using 3 methods, convex polygons with all locations, convex polygons and 50 randomly selected locations, and 90% and 99% harmonic mean home ranges (HMH). Only results for the second method are presented here. For 6 females, home ranges were 8.1 - 39.1 km² in size ($\bar{x}$ = 16.3), and for 7 males, the range was 10.6 - 78.2 km² ($\bar{x}$ = 30.9). These means did not differ (*t*-test). There was only 1 instance of 2 males using an overlap area. However, the overlap was not present in 50% HMH, thus areas of intensive use did not overlap. Similarily, 2 females used an 75 ha overlap, with no overlap present in the 50% HMHs. Female-male overlap was extensive. One incidence of male-male aggression was recorded. Home ranges of females were stable in size and location all year. Males frequently made outside trips during February to April, trespassing in the home ranges of other adult males for 1-2 days. The median of male home ranges was 25.5 km² and 12.2 km² for females. The median home range may be a more useful measure because of the large variability in mean home range size.

DENSITY: No transients were present in the population. A maximum density of residents calculated using the median home range was 1/8.3 km², and a summer and fall density (including kits) was 1/2.8 km². In a core area of 200 km², 10 fisher (4 M, 6F) were present, providing a density of 1/20 km². The actual density probably was higher because of the presence of non-collared fishers. If reproduction is conservatively estimated as 1.4 young / female, a minimum summer density is 1/10.5 km². Thus, actual densities likely ranged from 1/2.8 - 1/10.5 km² in summer, and 1/8.3 to 1/20.0 km² in winter.

TRAPPING MORTALITY was greatest among juveniles of both sexes (10 of 17), and least among adult females (2 of 13).

HABITAT USE: The year was split into spring (Mar-May), summer (Jun-Aug), fall (Sep-Nov), and winter (Dec-Feb). Habitat use was determined using radio locations and tracking. Availability of habitats within forested lands was determined from transects, as was prey availability. All aerial locations (n = 782) were in forested habitat, although only 83% of the study area was forested. Deciduous stands were used proportionately less than available, during all seasons. Coniferous stands were used more in all seasons except summer. Mixed stands were used in proportion to availability during all seasons. Scrub stands were used less during winter and spring. Wetlands were used less in all seasons except fall. For 33.8 km, 56 fisher trails were followed, and availability was estimated using 46.5 km in 18 transects. Fishers used coniferous overstories more, and hardwood, mixed and scrub, less than availability. Stands with no understory and sparse coniferous understories were used most frequently. However, the use by fishers of dense patches containing snowshoe hare trails was underestimated.

RESTING SITES were of 3 types, ground burrows, tree cavities, and tree nests. Nests were used most often all year, generally in "witches' brooms" (clumped growths) in balsam fir. Squirrel and raptor nests were used occasionally. Ground burrows, likely excavated by woodchucks, were used more in winter. Although fishers tunnelled through snow to burrows, they never used snow dens. Tree cavities were used during fall and spring, when there was no snow, nights were cool (<0 C) and days mild. All tree cavities were in hollow aspen. These were used from 2-12 weeks. Others were rarely used. Resting sites often occured in forest blocks <0.5 ha in size. Three adult females used tree cavities as NATAL DENS, all in hollow aspen.

Little evidence for selection by fisher of particular forest types was observed. Patches of snowshoe hare habitat appeared to be important foraging areas but this use was not quantified. There was no indication of fisher searching for porcupine or dens. Only male fishers were found with fresh quills. Fishers may be better adapted to deciduous and transitional habitats, rather than northern coniferous forests. Mature coniferous forest may not be optimum fisher habitat because deep snow restricts fisher movements. In the southern part of its range, optimum habitat is a diversity of forest types with high interspersion. The quality of habitat decreases when stands are >75% conifers. Small (5 ha) forest openings provide diversity. Fishers tolerated a high degree of human presence.

DIETS: From December to March, 68 scats collected on trails contained 20 food types. Apples were a major food item, comprising 34% of all scats. Apples were common around abandoned farms, which usually supported mixed second growth forest. Other identified foods were sciurids (25%), porcupine (21%), small mammals (22%), snowshoe hare (18%), birds (13%), and deer (7%). Because of the mild winters, carrion was uncommon in the study area.

7. _____. 1988*a*. An evaluation of techniques for capturing and radiocollaring fishers. Wildl. Soc. Bull. 16:417-422.

immobilization, livetrapping, Maine, radio-telemetry, techniques
Methods of trapping, recapturing, and radio-collaring fishers are reported and evaluated.

Forty fishers were captured using cages, radio-monitored cages, and padded-jaw foothold traps. The highest capture rate was in radio-equipped cages (1.94 captures/trap-night), probably because human scent was minimized. Trapping was most successful during October, March and April. Most (15) juvenile males were caught in October (1.52/trap-night), as were adult females (0.81/trap-night), and adult males were captured most frequently in March. Trapping of females during late March-April should be avoided because of denning. Fishers were recaptured using jab sticks, by darting, and by excavating burrows. Ear-tagging was unreliable because most fishers lost 1 or both tags over 3-12 months. Fishers were immobilized with intramuscular injections of ketamine hydrochloride, at doses of 20-60 mg/kg of body weight.

8. _____. 1988*b* (abstract). Behaviour and reproductive ecology of fishers in south-central Maine. Am. Soc. Mammalogists, 68th Ann. Meeting, Clemson, S.C.

behaviour, breeding, movements, natal dens, reproduction

ABSTRACT: Fisher (*Martes pennanti*) reproductive ecology was studied by observing movements of 43 radiocollared fishers in south-central Maine from February 1984-August 1987. During the March-April mating season, males travelled extensively outside their established ranges, but females did not change their movement patterns. Six females produced offspring in tree cavities. Natal dens were used for 8-12 weeks beginning in March or early April. Females with young were more active during summer than those without offspring. Juveniles remained with their mothers at least until August, and were independent by the end of September. Juvenile males travelled extensively during fall, winter, and spring, before establishing stable ranges during their second summer. The maximum denning rate during the study was 75%, in contrast to pregnancy rates of ≥95% found by previous studies. I propose that reproductive success may depend on the physical condition of females during fall or winter. Delayed implantation may allow mating to occur at a time of low energy demand on both males and females, and to allow females to interrupt gestation if they are not in sufficiently good condition during winter.

9. Asdell, S.A. 1964. Patterns of mammalian reproduction. Cornell University Press, Ithaca, N. Y. 670pp. (fisher p. 462).

natality, reproduction
A short summary of breeding, gestation length, litter size, and corpora lutea counts.

10. Audubon, J.J., and J. Bachman. 1894. Quadrupeds of North America. Vol I.: 307-315 (fisher).

description, distribution, names, pelt colour
An historical and partially anecdotal account of fisher distribution and biology.

The hunting of fisher by tracking females to den trees is described, as is arboreal behaviour by a fisher. Trappers only catch fishers at night. Fishers prefer low swampy ground. Diet consists of red squirrels, raccoons, and frogs. Fishers will follow traplines.

11. Bailey, V. 1936. The mammals and life zones of Oregon. U.S. Dep. of Agriculture, North American Fauna No. 55:1-416 (fisher p. 298-299).

distribution (map), habitat, Oregon
Distribution, habitat, and life history are described.

The distribution of West Coast fishers ranges from British Columbia south through Washington and Oregon to northern California and through the Coast Ranges. No records are available for the Blue Montains. In Oregon, fishers occupy the cool humid Coast Ranges and coniferous coastal forest. They "are rarely found far from cover of spruce and pine".

12. Baker, R.H. 1983. Michigan mammals. Michigan State University Press, 642pp. (fisher p. 462-472).

distribution, Michigan, review

A comprehensive review of morphology, distribution, and life history. A good reference on distribution of fishers in Michigan, and the successful reintroduction.

13. Balser, D.S., and W.H. Longley. 1966. Increase of the fisher in Minnesota. J. of Mammal. 47:547-550.

distribution, habitat, harvests, Minnesota
An account of increasing numbers of fisher in the state.

Fishers have been protected in Minnesota since at least 1933. Present distribution is primarily the northeast corner of Minnesota. Historically, fishers may have occupied most of the wooded areas of the state, including hardwood forests.

14. Bandy, P.J. 1952. A study of the fur-bearing mammals of the Subalpine and Columbia forest regions of British Columbia in relation to fur production from 1929 to 1949. Unpubl. B.A. Thesis, University of British Columbia. 82pp.

British Columiba, distribution, furbearers, habitat, harvests
Fur returns from traplines within the Subalpine and Columbia Forests were used to predict habitat productivity.

Productivity of habitats was calculated as the number of area required to produce 1 fisher pelt per annum. Data were fur harvests from 455 traplines held by non-native trappers and trapped during 1929-30 to 1949-59. In the southern forests, the lower valleys were the most productive, and in the northern Subalpine Forest, the dense forests of the Rocky Mountain Trench yielded a comparatively lage number of pelts. Fishers apparently were absent from the extreme south of the Subalpine and Columbia Forests. The average area required to produce 1 pelt per annum, calculated over 4 5-year periods, was 2765 km^2. (*see also Edwards 1950, Edwards and Cowan 1957, MacLeod 1950*).

15. Banfield, A.W.F. 1974. The mammals of Canada. University of Toronto Press, Ontario. (fisher) p. 318-320.

biology, Canada, distribution (map), review, taxonomy
A review of fisher life history and distribution.

"Recent studies have indicated that there is probably one variable form in North America." A map of distribution in Canada indicates fisher are extinct in southwest British Columbia (mainland), south east British Columbia, the southernmost parts of Ontario and Quebec, and Nova Scotia (although reintroductions are also noted).

16. Barkalow, F.S. 1961. The porcupine and fisher in Alabama archaeological sites. J. Mammal. 42:544-545.

Alabama, archaeology, porcupine
Fossilized porcupine and fisher remains were found in human burial sites.

17. Benson, D.A. 1959. The fisher in Nova Scotia. J. Mammal. 40:451.

distribution, re-establishment, Nova Scotia
Fishers were extinct in Nova Scotia by 1940. A few ranch stock fishers were reintroduced during 1947 and 1948.

18. Blanchard, H. 1964. Weight of a large fisher. J. Mammal. 45:487-488.

Maine, weights
A record weight for a trapped male fisher was 9056 g.

19. Boise, C.M. 1975. Skull measurements as criteria for aging fishers. N. Y. Fish and Game J. 22:32-37.

age determination, New York, skull
1971-72, 1972-73
An attempt was made to age 42 fishers using skull measurements.

Age (juvenile, adult) of males was determined from bacula development. Females were classed as adults if a saggital crest was present. Zygomatic breadth, greatest skull length, and the width of the postorbital constriction varied significantly with age, although overlap occurred among age classes. Low sample sizes may have produced misleading results.

20. Bradle, B.J. 1957. The fisher returns to Wisconsin. Wisc. Conserv. Bull. 22:9-11.

popular account, porcupine, reintroduction, Wisconsin
Fishers were reintroduced into Nicolet Forest, Wisconsin, for porcupine control.

21. Brander, R.B., and D.J. Books. 1973. Return of the fisher. Nat. Hist. 82(1):52-57.

Canada, diets, distribution, habitat, hunting behaviour, popular account, porcupine, predator-prey relationship, United States
One of the best popular accounts, the authors provide accurate accounts of changes in distribution, reintroductions, diets, and the relationship of fisher with porcupine.

The original range of the fisher was the northern coniferous forest, from coast to coast. By the 1900's fisher populations had declined due to overharvesting and habitat loss. Increased trapper effort was due to an increase in pelt value. In 1920, fisher pelt prices peaked, a mean of $85 (CAN), to a maximum of $300. Many fishers were also hunted. By the 1930's fisher were almost exterminated in the United States, except for small populations in Maine, the White Mountains (New Hampshire) and Adirondack Mountains (New York), northeast Minnesota, and California. By 1940, fishers were extinct in Nova Scotia. Concerns prompted closure of trapping seasons, 1922 in Wisconsin, 1929 in Minnesota, 1935 in New Hampshire, 1936 in New York and Wyoming, 1937 in Maine and Oregon, and 1946 in California. Seasons were rarely closed in Canada but the registration of traplines helped to control harvests. By the 1950's, demand changed from fisher to spotted cats. Fisher prices dropped to $10-$15 per pelt. Decrease in demand, restoration of habitat, and restocking in some areas helped to increase fisher numbers.

Fishers, as the only animal able to control porcupines, have added public acceptance. In a first release in Michigan, porcupine densities decreased from 94 to 23 per km^2. Reintroduced fisher populations seem to be reaching an equilibrium with porcupine in some areas. A decrease in the number of secure porcupine dens (in live, hollow trees, >20" dbh of yellow birch, elm, sugar maple or basswood) would increase the susceptibility of porcupine to fisher predation and upset the predator-prey balance.

22. Brown, L.N. 1965. A fisher, *Martes pennanti*, in Sheridan County, Wyoming. The Southwestern Nat. 10:143.

distribution, Wyoming

Fisher are only known from the extreme northwest corner of Wyoming. In 1964, an adult male weighing 7.1 kg was killed 288 km to the southwest from this area.

23. Brown, M.K., and G.R. Parsons. 1983. Movement of a male fisher in southern New York. N. Y. Fish and Game J. 30:114-115.

dispersal, movements, New York, reintroduction

Fisher were transplanted in 1976 from northern New York to the Catskill Mountains. One 6.3 kg male travelled 136 km in 10 months. This fisher was re-released from the original point and travelled a straight line distance of 163 km in 11 months. These movements may be atypical because this fisher was previously held captive. Two other males transferred from the wild were recovered 2.5 and 17.5 km from release points, and 2 females, 22.8 and 23.5 km from release points. *The time span is not provided.*

24. Brown, M.K., and G. Will. 1979. Food habits of the fisher in northern New York. N. Y. Fish and Game J. 26:87-92.

diets, New York, porcupine, snowshoe hare
Oct 25 - Dec 31 1975, Oct 16 - Jan 2 1976-77.

Foods found in 405 gastro-intestinal tracts from fishers submitted by trappers are presented. Most specimens were trapped in November and December. Of the 405, tracts 20% were empty. In the remaining 322, 961 items were identified representing 48% mammals (25 species), 44% vegetation, 4% birds (8 species), 1% fish and 1% insects. Principal prey species were red squirrel (20%), white-tailed deer (bait, carrion) (19%), small mammals (17%), and snowshoe hare (12%). Porcupine occurred in 7% of tracts.

25. Buck, S., C. Mullis, and A. Mossman. 1979. A radio telemetry study of fishers in northwestern California. Cal-Neva Wildl. Trans. 1979: 166-172.

California, home range use, livetrapping, radio-telemetry
November 1977 - December 1978
Objectives were to determine seasonal habitat use; examine the responses of fishers to logging and associated road construction; estimate density; provide information on diets, denning sites, and interactions with other carnivores; and develop management guidelines. Initial results are presented.

The study area was 153 km^2 of the Trinity National Forest. Lower elevations supported Douglas-fir cover types, and higher elevations mixed Douglas-fir types. Eight males (4 adults, 4 juveniles) and 3 females (2 adult, 1 1-year-old) were trapped. All captures were on edges or along steams. HOME RANGES were biased by a preponderance of summer data. Home

range sizes for 3 adult males were 13.8 (Nov - Sep, n = 47 locations), 10.4 (Feb - Sep, n = 51), and 17.8 km^2 (Mar -Sep, n = 43). Home range sizes for 2 adult females were 6.8 (Nov - Feb, n = 8), and 3.6 km^2 (Feb - Jul, n = 12). An adult male moved out of his regular home range during the breeding season. No seasonal shifts in ELEVATION were observed. Elevations used ranged from 472 m - 1356 m. Three RESTING SITES were located, 1 was underground at the base of a Douglas-fir snag, 2 were associated with downed logs of 75-100 cm diameter. *The study is described as work in progress, however additional references were either unavailable or not located.*

26. Bulmer, M.G. 1974. A statistical analysis of the 10-year cycle in Canada. J. Anim. Ecol. 43:701-718.

Canada, furbearers, population cycles, snowshoe hare
The essence of this paper and the succeeding two is that most furbearers, including fishers, exhibit population cycles.

The ten-year cycle has 2 main features, a regular period and an irregular amplitude. A statistical model is developed which includes a dependence on population size, as well as a periodic function. Data were fur harvests of Canada between 1751 and 1969. The 10-year cycle existed, for at least part of this period, for coyote, fisher, red fox, lynx, marten, mink, muskrat, skunk, wolf, wolverine, and snowshoe hare. A simple theory is that the cycle in all species is caused, directly or indirectly, by the cycle in snowshoe hare. *See also Hewitt 1921, Cowan 1938, Butler 1953, Bulmer 1975.*

27. _____. 1975. Phase relations in the ten-year cycle. J. Anim. Ecol. 44:609-621.

Canada, furbearers, harvests, population cycles.

It is suggested that the 10-year cycle in any cyclic species, except snowshoe hare, is driven by another cyclic species which either eats it or is eaten by it. A quantitative model is developed to investigate phase relationships between predator and prey. Some species were cyclic but no longer are. Marten ceased to be cyclic before 1920. Fisher, lynx, mink and wolverine continue to be cyclic. Fisher did not cycle during 1751 to 1847 but did from 1920 to 1969. A break in cyclicity is attributed to habitat disturbances and increasing trapping pressure. *See also Hewitt 1921, Cowan 1938, Butler 1953, Bulmer 1974.*

28. Butler, R.L. 1953. The nature of cycles in populations of Canadian mammals. Can. J. Zool. 31:242-262.

Canada, population cycles, snowshoe hare, furbearers
1919-1951

Harvests of furbearers from 1915 were examined to determine whether peaks are cyclic, or arise by chance. Peaks in harvests did not occur randomly, and did not necessarily occur in the same year throughout Canada. Fisher was grouped with fox and lynx with respect to frequency of peak harvests. The "good years" for lynx, fox, fisher, coyote, and wolf, are closely connected to those for snowshoe hare. Fisher appeared to respond more slowly to the

good years. This is attributed to delayed implantation, an unalterable biological lag. *See also Hewitt 1921, Cowan 1938, Bulmer 1974, 1975.*

29. Carlson, B.L., and V.G. Sasseville. 1984. *Dracunculus insignis* in fishers (*Martes pennanti*) in New Hampshire. J. Am.. Vet. Med. Assoc. 185:1327.

New Hampshire, parasites
1982-83, 1983-84

Female worms containing larvae were found in the legs of 37 (5%) of 748 fishers examined. Lesions were inocuous, causing minimal tissue and inflammatory cell reaction. "It appears that dracunculiasis in fishers is a mild condition, without secondary infections".

30. ____, and S.W. Nielsen. 1985. Thyroid adenoma and ovarian luteinization in an aged fisher (*Martes pennanti*). J. Wildl. Dis. 21:320-324.

diseases
Pathologic findings in an 11-year-old female fisher raised in captivity since birth are described.

31. Chitwood, B.G. 1932. Occurrence of *Uncinaria stenocephala* from the fisher, *Mustela* sp. J. Parasitol. 18:307.

parasites
A short note, documenting a first occurrence.

32. Clem, M.K. 1977*a*. Food habits, weight changes, and habitat selection of fisher (*Martes pennanti*) during winter. M.Sc. Thesis, University of Guelph, Ontario. 49pp.

condition, diets, fat indices, harvest sex ratios, Ontario, weights
1972-73, 1973-74, 25 October - 28 February

Objectives were to estimate winter diets; examine diets with respect to sex, location, and time of capture; report on monthly changes of internal fat; examine harvest sex ratios; and estimate habitat use.

DATA were 324 carcasses trapped in the Algonquin, Parry Sound, and Bracebridge regions. Prey in stomachs and gastro-intestinal tracts were identified. The relative abundance and availability of prey were not determined. Mesenteric fat was selected as being the most representative of body fat. Empty stomachs, intestines, and mesenteric fat were wet-weighed. Habitat use was assessed by livetrapping, marking, and recapturing. Ten trails were followed over 2 winters.

DIETS: Major food items were snowshoe hare, muskrat, porcupine, small mammals and birds. Diets differed between 2 arbritaily designated areas and between years, for both sexes. Porcupines were consumed predominately in November, snowshoe hares in December, and muskrats were consumed all winter. Differences between diets of males and females were few.

WEIGHTS AND FAT LEVELS: Carcass weights were lowest for both sexes in December, highest in February for males, and in November for females. The mean weights of intestinal tracts, stomachs and mesenteric fats were higher for males in all months. (*The amount of fat that can be maintained is a function of body weight. This result may be due to the larger size of male fishers*). Generally, mean weights were higher in November.

HARVEST SEX RATIOS in 1972-73 were not different from 1:1 but were biased to females in 1973-74. Females may be more susceptible to being trapped.

HABITAT USE: Fisher appeared to be foraging in areas where conifer cover types predominated. *However, traps were not placed in habitats in proportion to their relative availability and the utility of this analysis is limited. The author notes that time and financial constraints prohibited a proper assessment.*

33. _____. 1977*b*. Interspecific relationship of fishers and martens in Ontario during winter. Pages 165-172 *in* Phillips, R.L., and C. Jonkel, eds. Proc. of the 1975 Predator Symposium. Montana For. and Conserv. Exp. Stn., Univ. of Montana, Missoula.

competition, condition, diets, fat indices, marten, Ontario
1973-74
Competitive interaction between fishers and marten may be important in controlling distributions and population levels. This hypothesis was investigated by comparing winter diets.

MATERIALS were 385 fisher, and 184 marten carcasses collected from trappers. Results for fisher are generally the same as those in Clem 1977*a*. For comparisons, 22 prey items were selected on the basis of dietary importance to both species. Abundance and availability of prey were not determined. Empty stomachs, intestinal tracts, and mesenteric fat were wet-weighed as an index to condition.

Fisher and marten diets did not overlap until December. Diets from December to the end of February were similar. Fishers ate larger prey than marten. Weight losses in female fishers during November may demonstrate dietary and physiological changes.

34. Cook, D.B., and W.J. Hamilton, Jr. 1957. The forest, the fisher, and the porcupine. J. Forestry. 55:719-722.

distribution (map), popular account, porcupine, re-establishment, United States

The fisher is an effective predator of porcupine and is a recommended control agent.

35. Cottrell, W. 1978. The fisher (*Martes pennanti*) in Maryland. J. Mammal. 59:886.

distribution, reintroduction, Maryland, West Virginia

In 1969, West Virginia reintroduced 23 fisher, some of which were released near the Maryland border. The establishment of fisher in Maryland was verified during 1974, 1975, and 1977.

36. Coulter, M.W. 1960. The status and distribution of fisher in Maine. J. Mammal. 41:1-9.

density, dispersal, distribution, Maine
A summary of the details of the increase of fisher in Maine.

In the 1800's fishers were present in Maine but were not abundant. In the 1900-1930's, high pelt prices promoted over-harvesting. In the mid-1930's, fisher were uncommon. A closed season was instituted in 1937. In 1949, wardens reported fishers as common or abundant; 10 years earlier, they were documented as rare or absent. Trapping was allowed in 1950. Increases originated from the Moosehead Plateau, an area with numerous mountains 1200-1500 m in elevation, lack of settlement, and a vast spruce-fir-northern hardwood forest. (Fishers were never extirpated from this region). After 1950, fisher continued to increase in numbers and disperse into other parts of Maine.
DISPERSAL was most rapid in hilly country, regardless of the forest cover present. Areas of low-lying forest containing a high proportion of bog or generally soggy area, even if densely forested, were not invaded rapidly. In 7 years, the fisher range increased from 33 800 km² to 59 800 km², an expansion of approximately 75%. The DENSITY of populations varies greatly. In good habitat, densities were estimated as 1 fisher per 10-12 km². Protection appears to be the most important factor responsible for the increase of fishers.

37. _____. 1966. Ecology and management of fishers in Maine. Ph.D. Thesis, State Univ., College of For., Syracuse Univ., N. Y. 196pp.

age determination, density, diets, dispersal, forest cover, habitat, harvest sex ratios, harvests, Maine, management, morphology, pelts, predator-prey, porcupine, reproduction
1950-1960 (field), 1950-1963 (carcasses)
This seminal paper describes the first extensive study of fisher biology, through the use of snow tracking, an analysis of 376 carcasses, and observations of live and captive fishers.
1950-1963

DATA were collected from winter tracking (1950-1966), observations of penned fishers (1963-1966) and 376 carcasses. The range of fishers in Maine doubled to approximately 65 000 km² over the duration of the study. Rates of dispersal were 8 km per year in northern Maine and 14 km per year in southern Maine. A broad river slowed penetration into one region. Densities were greater than 1/2.6 km² in some areas, but these were believed temporary. Fishers were solitary, primarily nocturnal and terrestrial during winter.

AGE DETERMINATION AND MORPHOLOGY: Unfused cranial sutures were characteristic of juveniles. The length of the saggital crest in females and the overhang of the crest in males

distinguished juveniles from adults. Colour variations were apparent between age classes, sexes, and seasons but not between populations. Molting occurred in late summer. Males always had more fat in relation to body size than females.

REPRODUCTION: Parturition occurred from late February to 1 April. A female killed in southern Maine in mid-January had 3 well developed embyros. Two females trapped in late March had recently bred. A female trapped on March 27 had not bred and displayed no signs of estrus. Kits were altricial and averaged 3 per female. Eyes of kits opened at 53 days. Nursing continued into the fourth month. Dispersal occurred before late November.

WINTER DIETS: Predominant foods in 242 gastro-intestinal tracts were snowshoe hare, porcupine, white-tailed deer (carrion), birds, shrews, mice, and sciurids. Fishers killed porcupines by attacks to the head region. Quills were present in body tissues of 127 of 365 carcasses. Although parasitism was frequent, diseases were uncommon. The fisher is a new host for *Taenia* sp. and *Alaria* sp.

HABITAT: Spruce-fir type forests (pole stage or older) were used more than available. However, fishers also lived in extensive hardwood stands where conifers were not abundant, particularly in southwestern Maine. Fishers avoided crossing fields or frozen lakes and highway right-of-ways. Resting sites ($n = 48$) were often in brush piles, under logs, under the upturned roots of a windthrown tree, in tree dens, in a hollow log, and 1 was in a ground burrow.

HARVESTS: The harvest was biased to males when trapping pressure was light and to females when trapping pressure was high. Males were trapped more frequently in late winter, due to the increased activity of breeding.

38. Cowan, I. M. 1938. The fur trade and the fur cycle: 1825-1857. B.C. Hist. Q. 2: 19-30.

harvests, population cycles, snowshoe hare, British Columbia
1825-1857
Explanations for the apparent cycling in furbearer populations are offered.

Most mammals display population cycles. Voles, or field mice cycle about every 4 years. Snowshoe hare cycle, on average, every 9.7 years. Fishers are never as abundant as marten. Because of a highly diverse diet, fisher do not display the pronounced fluctuations seen in other, more specialized species. Fishers cycle every 9.7 years, but display a lag because of the availability of other food sources. "It takes from 2 to 4 years for the fisher to deplete the other available food sources, and the effect of the rabbit depression is ... deferred rather than immediate...". *See also Butler 1953; Bulmer 1974, 1975.*

39. Craig, R.E., and R.A. Borecky. 1976. Metastrongyles (Nematoda: Metastrongyloidea) of fisher (*Martes pennanti*) from Ontario. Can. J. Zool. 54: 806-807.

Ontario (central), parasites
1972-1974 winters

Trilobostrongylus bioccai (lungworms) were found in 21% of 184 trapped fisher, *Crenosoma petrowi* in 15%, and *Sobolevingylus* sp. in 2%. *Effects on the health of fishers are not discussed.*

40. Crichton, V.F.J., and M. Beverley-Burton. 1974. Distribution and prevalence of *Dracunculus* spp. (Nematoda: Dracunculoidea) in mammals in Ontario. Can. J. Zool. 52: 163-167.

Ontario, parasites
1969-1972, Oct-Apr

Of the 1147 carcasses (13 species) examined, 19 individuals were fisher. All occurrences (7) of *Dracunculus* spp. in fisher were from southern Ontario. *Effects on health are not discussed.*

41. Cunningham, J.D. 1959. The wolverine and fisher in the Yosemite region. J. Mammal. 40:614-615.

California, distribution
Two sightings of fishers are reported.

42. Dagg, A.I., D. Leach, and G. Summer-Smith. 1975. Fusion of the distal femoral epiphysis in male and female marten and fisher. Can. J. Zool. 53: 1514-1518.

age determination, marten, morphology, Ontario (Algonquin)
1973-1974, November - February.
Radiography is used to determine the time of fusion of epiphyses of femurs in an attempt to age winter-trapped fisher.

DATA were 142 marten and 391 fisher carcasses provided by trappers. Canine teeth were aged by cementum analysis. Radiography was used to determine the time of fusion of the distal femoral epiphysis.

RESULTS AND DISCUSSION: Fusion is complete by 1 November in females. In males, fusion occurred later. For some males (10-11 months old), fusion had not begun by February. The time of fusion in males may be spread over 4 months. Scar lines persisted in more males than females. The time of fusion is a function of body size and also possibly of sex. Radiographic determination of the degree of fusion of the distal femoral epiphysis is not a useful indicator of age.

43. Dalquest, W.W. 1948. Mammals of Washington. Univ. of Kansas Publ., Mus. of Nat. Hist. 2: (fisher) 187-189.

distribution (map), habitat, Washington

The fisher is rare in Washington and seems never to have been common. Distribution is probably confined to the Cascade and Olympic Mountains. A few may occur in northeastern

Washington, the Blue Mountains and the Willapa Hills. Most trappers agree that fishers occupy lower elevations than do marten.

44. Daniel, M.J. 1960. Porcupine quills in viscera of fisher. J. Mammal. 41:133.

Ontario, porcupine
1956-57
Porcupine quills were found in the adrenal gland, lungs, omental fat, and in the peritoneal cavity, extending from the stomach and small intestine. No ill effects were noted.

45. Davison, R.P. 1975. The efficiency of food utilization and energy requirements of captive female fishers. M.Sc. Thesis, Univ. of New Hampshire, Concorde. 53pp.

deer, diets, energetics, snowshoe hare

Objectives were to evaluate the relative value of 4 diets: snowshoe hare, white-tailed deer meat and viscera, small mammals (meadow voles, short-tailed shrews, white-footed mice), and quails; and to estimate maintenance energy requirements.

STUDY ANIMALS were 4 captive females, 2 juveniles and 2 adults. Crude protein content was highest in snowshoe hare (72%) and lowest in quails (49%). Percent fat was highest in quails (39%), and lowest in snowshoe hare (3.7%). Body weight fluctuated widely and was not a sensitive index of growth or fattening. The efficiency of conversion of dietary nitrogen to body tissue was greater on the hare diet. The mean fasting heat production was 162 kcal / kg $W^{0.75}$ (for active fishers). The combination of age classes, small sample, and use of only female fishers preclude general conclusions.

46. Davison, R.P., M.W. Mautz, H.H. Hayes, and J.B. Holter. 1978. The efficiency of food utilization and energy requirements of captive female fishers. J. Wildl. Manage. 42: 811-821.

see Davison (1975).

47. deVos, A. 1951. Overflow and dispersal of marten and fisher from wildlife refuges. J. Wildl. Manage. 15: 164-175.

dispersal, marten, Ontario (Chapleau Forest District), refuge
The importance of a wildlife refuge for the re-establishment of marten and fisher in a depleted area is investigated.

METHODS: Fur harvests from 1941-42 to 1949-50 were examined to determine the relative abundance of marten and fisher at increasing distances from wildlife refuges.

RESULTS: Fisher and marten were more abundant close to preserves. Establishment premitted dispersal into surrounding areas. Fisher colonized areas of the best habitats first: more mature forest, closer to climax stage, and a greater percentage in coniferous trees. The increases observed may have been due to a cyclic high. However, this explanation does not account for

the overflow observed from the preserve and not from the residual pockets of fisher. A progressive decrease in abundance from the game preserve occurred for marten, but was less evident for fisher. However, pockets of fisher existed before the preserve was established.

48. _____. 1951. Recent findings in fisher and marten ecology and management. Trans. North Am. Wildl. and Nat. Resour. Conf. 16: 498-507.

diets, habitat use, harvests, harvest sex ratio, management, marten, movements, Ontario
1948-1951 (3 winters, 2 summers).
Results of a snow tracking study on fisher and marten.

MOVEMENTS of fisher were circuital and governed by the availability of food, topography and cover; food was the most important factor. Males had larger home ranges than females. Fisher are less arboreal than noted in the literature, but have a "liking" for walking on fallen logs.

DIETS were estimated from the contents of 32 stomachs. Major prey were snowshoe hare (31%), porcupine (20%), fish (11%), small mammals (6%), and birds (4%).

HABITAT: Mixed and pure stands of trembling aspen and paper birch were poor habitat, as were recently logged and burned-over areas. Forest cover was an important factor in habitat use. Later seral stages also provided more denning opportunities. The low abundance of small mammals and other prey in black spruce muskegs make these habitats unproductive. Fishers are better adapted to earlier successional stages than are marten.

HARVESTS: The sex ratio of fishers in the 1949-50 harvest of Ontario were slightly biased to females. The 1950-51 harvest had a slight bias to males.

49. _____. 1952. Ecology and management of fisher and marten in Ontario. Ontario Dep. of Lands and For., Tech. Bull., Wildl. Ser. 1, 90pp.

age determination, arboreal activity, condition, diets, distribution, habitat use, harvests, harvest sex ratios, management, marten, movements, Ontario (Chapleau District), parasites, pelts, refuges, resting sites, review, snow cover, snow tracking
January 1948 - April 1952
Behaviour of fishers was determined from snow tracking and extensive information from trappers. Management guidelines were developed. "This manuscript was presented in a more complete form as a Ph.D. thesis for the University of Wisconsin 1951".

DATA were collected by snow tracking and from interviews with trappers. Trappers reported that fishers tend to make circuital movements. These ranged from 13-32 km in diameter and 64-160 km in length. It was not possible to delineate home ranges. Movements appeared to be restricted by heavy snowfall. Fishers were solitary except for family groups and mating pairs in the spring. Arboreal activity was rarely noted and fishers are probably less arboreal than usually described. Fishers do not hesitate to swim when advantageous.

RESTING SITES: "The fisher is not particular in its requirements for the site of a den". Temporary resting sites were holes under large boulders, dens dug in the snow, hollow logs and brush piles. Two temporary resting sites were in deserted beaver houses. If a large supply of food is nearby, such as an ungulate kill, a fisher may den up from several days to a few weeks. Fishers den up during heavy snowfall.

DIETS were described using 59 stomachs and gastro-intestinal tracts and 9 scats collected during 1933-1952. Predominant prey were snowshoe hare, porcupine, carrion (white-tailed deer and moose), small mammals and sciurds. The habit of feeding on carrion is well developed, especially where available. Carcasses (n = 22) had little fat deposits but appeared to be in good to fair condition. Parasites were listed (*see Sprent 1952)*. The utility of skull measurements for aging was investigated, however only a small sample of skulls was available and known age material was unavailable. Harvest sex ratios were biased to females.

HABITAT: Fishers have general habitat requirements, occurring in mixed, coniferous, and hardwood stands, in flat as well as in rocky country. Fishers were rarely seen in open, second-growth stands and only occasionally in recently burned-over areas. They were rare to absent in extensive even-aged stands of aspen-white birch. Recent burns and cedar swamps were visited, probably because of the occurrence of snowshoe hare. Fishers appear to be more adaptable to environmental changes than are marten. Fishers have disappeared from most of the settled portions of southern Ontario. They were relatively common in northern and central Ontario but population sizes have decreased. Contributing causes were overtrapping, the use of poison as a trapping method, hunting of females, and extensive habitat loss due to logging, fires, and settlement. The establishment of refuges is an effective method of increasing populations. Logging, which provides for well-dispersed blocks of mature timber, might result in a higher carrying capacity for fishers. Trappers may make brushpiles to increase den sites and provide cover.

50. Dick, T.A., B. Kingscote, M.A. Strickland, and C.W. Douglas. 1986. Sylvatic trichinosis in Ontario, Canada. J. Wildl. Dis. 22: 42-47.

diseases, marten, Ontario, parasites
1972-1982, November - February
Trichinosis is a reportable zoonotic disease in Canada. The occurrence of larvae of *Trichinella* in selected wild mammals and the importance of these hosts in its transmission were determined.

Fisher and marten were the main hosts of *Trichinella spiralis*. Of 18 species, 83 of 1821 (5%) fisher and 68 of 1980 (3%) marten were infected with larvae. Larvae were absent from all other hosts, except for 1 of 12 mink. The prevalence of larvae increased with the age of fisher and marten. In juveniles, incidence increased with time and was highest in February. The main transmission route of sylvatic trichinosis in boreal regions of central Canada is through marten and fisher. Carrion likely plays a role in this transmission.

51. _____, and R.D. Leonard. 1979. Helminth parasites of fisher, *Martes pennanti* (Erxleben), from Manitoba, Canada. J. Wildl. Dis. 15: 409-412.

Manitoba, parasites
Parasites of fisher, their distribution, prevalence, and intensity based on host age are described.

DATA were 157 fisher carcasses. Gastro-intestinal tracts, lungs, and hearts were examined. Helminths were recovered from 52 of 162 fisher. Only for *T. sibirica* were there sex differences (19 F, 6 M), but no age differences. Juveniles had higher prevalences of *B. devosi* and *Physaloptera* sp. than adults (36% vs 19%, 6% vs 3%, respectively). Prevalance varied among the 4 sample areas. Lungworms, kidney worms, and guinea worms were not detected.

52. Dilworth, T.G. 1975. Status and distribution of fisher and marten in New Brunswick. Can. Field-Nat. 88: 495-498.

distribution, New Brunswick, reintroduction

The distribution of fisher in New Brunswick from 1775 to 1971 is reviewed. Presently, fisher are common in northern and central regions. From 1966-1968, 25 fisher were transplanted from northern New Brunswick to southern parts of the province. No evidence of reproduction is available.

53. Dix, L.M., and M.A. Strickland. 1986. Sex and age-class determination for fisher using radiographs of canine teeth: a critique. J. Wildl. Manage. 50: 275-276.

age determination (technique), radiographs
A critique of the interpretation of Jenks *et al.* (1984) of width ratios in radiographs of canine teeth.

Jenks *et al.* (1984) misinterpreted their 99% confidence limits and wrongly concluded that fisher 3-years-old could be aged from the width ratios of the pulp cavity in canines. Tolerance limits are the appropriate confidence interval, not confidence limits. With 95% tolerance limits, 3 year and older fishers could not be distinguished. Width ratios, did, however, separate juveniles from adults ≥1-year-old. (*see also Jenks et al. 1984, 1986*).

54. Dixon, J. 1925. A closed season needed for fisher, marten and wolverine in California. Calif. Fish and Game 11: 23-25.

California, harvests
1920-1924

Harvests of fisher in California have declined (a loss of 67% in the 5-year period). The corresponding large increase in pelt prices indicate demand is high and that populations are also declining. A 3-year, closed season is recommended.

55. Dodds, D.G., and A.M. Martell. 1971. The recent status of the fisher, *Martes pennanti pennanti* (Erxleben), in Nova Scotia. Can. Field-Nat. 85: 63-65.

distribution, Nova Scotia, reintroduction

The distribution of fisher in Nova Scotia is traced from 1708 to 1970. A total of 92 fisher were reintroduced during 1947-1948 and 1963-1966. Fisher are currently successfully re-established.

56. Douglas, C.W., and M.A. Strickland, eds. 1979 (ms). Transactions of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset, Ont. 21-23 October 1979. 139pp.

age determination, age ratios, bacula, behaviour, density, delayed implantation, diseases, estrus, feeding, harvests, harvest rates, home range, Maine, management, Manitoba, marten, Massachusetts, Minnesota, morphology, mortality, movements, natality, New Hampshire, North Carolina, Nova Scotia, New York, Ontario, parasites, physiology, population cycles, population models, Quebec, refuges, reproduction, sex ratios, testes, Vermont, Wisconsin

Transcripts of discussions of the workshop and prepared submissions from managers and researchers, with an emphasis on current problems and management (individual reports are Kuehn and Berg 1979, Nevers 1979, and Petersen *et al.* 1977).

57. _____, and _____. 1987. Fisher. Chapter 40, pages 511-529 *in*: M.Novak *et al.* , eds. Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour:, Toronto. 1150pp.

activity, age determination, behaviour, blastocysts, breeding, condition, density, description, diets, distribution (map), fat indices, gestation, habitat use, harvests, home range, livetrapping, litter size, management, marten, morphology, mortality, natality, Ontario (Algonquin), parasites, parturition, pelts, population cycles, population models, primeness, re-establishment, reproduction, review, sex determination, skull, techniques

A comprehensive review of fisher distribution, life history, ecology, diets, behaviour, and management. Only results of Douglas and Strickland are included here. The data (including previously unpublished) are more than 6000 fisher carcasses trapped during 1972-1985.

MORPHOLOGY: Females usually have darker, silkier fur than males, and bring a higher price on the fur market. There is large intra-population variation in body size (lengths and weights). A mean ratio of pelted to whole carcasses ranged from 0.822 to 0.833 for all sex and age groups (n = 161).

DISTRIBUTION: Fishers were re-established in the western part of Algonquin by transferring 97 fishers over 6 winters (1957-63) into prime habitat. The local population has increased and 300-400 are harvested annually.

REPRODUCTION: Males were spermatic by 12 months of age. Sperm were present during February and March in males of all ages, but only 8% (3 of 39) of males examined from

November to January had sperm. Testes increased in weight over winter in all ages and testes of juveniles were adult size by March. Juvenile males, although spermatic, may not be effective breeders. The baculum increased in size and changed in shape with age. Young males may be less effective in inducing ovulation. Bacula of adults weighed more than those of juveniles during March and April.

None of the juvenile females (7-9 months old, $n = 476$) had corpora lutea. Developing follicles in ovaries indicated that ova would be released the next breeding season. Mean number of corpora lutea per pregnant female varied with age. Females aged 3.5-7.5 years had more corpora lutea (3.5-3.9). Counts may be lower in older females (>8 years, 3.4-3.6, $n = 10$). Of adult females ($n = 1173$), a mean of 97% were pregnant yearly. From 1973-1975, the population was being heavily trapped and was declining, and 92% of adult females were pregnant. This may have been a result of a shortage of adult males in the population. The breeding season is from late March to early April. Date of parturition is from 27 February to 15 April, although exceptions may occur. Three fishers trapped in December had developed fetuses that would have been born before 15 January. Another female, trapped on 9 March, had unimplanted blastocysts. Sex ratios of birth (F:M) were 45:55, not different from 1:1.

MORTALITY: Fisher have few enemies besides humans. Of more than 6000 fishers, 2 were killed by dogs and 1 had a badly necrotized mandible. A skeleton of a 7.5-year-old male had evidence of severe arthritis and bony overgrowths in the spine, joints, and jaw. Of 3464 fishers, 9% were pierced by porcupine quills, some internally. No significant damage, inflammation, or infection was apparent. Occasionally fishers are killed on highways. Intraspecific strife, assessed from scarring of pelts, occurred most frequently in juvenile males (163/307, 53%) and adult males (47/113, 42%). Frequencies in females were 16% (50/305) in juveniles, and 5% (7/153) in adults. Many internal and external parasites have been reported in fishers, but there is no evidence that they are significant mortality factors.

CONDITION: Over 90% of fishers had deposits of body fat, indicating they were in good condition. Adults had the least and males usually had more fat than females.

WINTER HABITAT USE was determined from questionnaires sent to trappers. Results (683 responses) were wetlands 23%, old mixed hardwood/conifer 21%, young mixed hardwood/conifer 21%, old hardwood forest 11%, old conifer forest 8%, young hardwood forest 8%, young conifer forest 6%, and other 2%. These results were similar to those reported for marten.

DENSITY: The 31 000-km² study area has supported a sustained annual harvest of approximately 1 fisher/25.9 km² for the past 5 years. This harvest is approximately 25% of the pretrapping population, indicating a fall density of approximately 1 fisher/6.5 km².

FISHER AND MARTEN: Harvest maps of Ontario suggest an inverse relationship in fisher and marten harvests. This may indicate a fisher-marten interaction or reflect different habitat requirements.

SEX AND AGE DETERMINATION: Males are longer and heavier than females, and adults are longer and heavier than juveniles, for both sexes. However, overlap precludes using length

and weight for aging. Age cannot be determined from pelt size and there is overlap between sexes. Baculum weights between ages overlap and cannot be used to age adults. A baculum weight of <1.5 g differentiates juveniles (0.5 years) from adults, for fisher caught before January. Zygomatic width, skull length and weight (cleaned skulls) may be used to separate sexes. The saggital crest is large in adult male fishers. It begins to form in males by 9-10 months but does not overhand the supraoccipital bone as it does in adults. Any female that has a crest is an adult, but not all adult females have crests.

REGULATING HARVESTS: An indicator of trapping intensity is the ratio of juveniles: females ≥2.5 years. Heavy trapping will provide a sample skewed to adult females, because the more vulnerable males in the population have been trapped. Many jurisdictions use periodic season closures to regulate populations. Fishers are highly susceptible to overharvesting.

58. Eadie, W.R., and W.J. Hamilton, Jr. 1958. Reproduction in the fisher in New York. N. Y. Fish and Game J. 5: 77-83.

age determination, New York, reproduction, skull development

Trappers provided 87 fall and winter-killed females. A mean of 2.72 corpora lutea were found in 22 pairs of ovaries. *Age determination by skull measurements and characteristics was attempted, but actual age classes were estimated on the presence or absence of corpora lutea.*

59. Earle, R.D. 1978. The fisher-porcupine relationship in upper Michigan. M.Sc. Thesis, Michigan Tech. Univ., Houghton. 126pp.

Michigan, porcupine, predator-prey, reintroduction
1975-1977
The effect of fisher predation on porcupine abundance in the Ottawa National Forest was examined.

An area with an established fisher population was compared to an area without fishers or with few fishers. The density of fishers was not assessed. The reintroduction of fisher into Wisconsin and Michigan is summarized. Density, sex ratio, weights, and age structures were determined for 2 populations. Data were porcupine sampled from the study area and the relative density of road killed porcupine. Porcupine were less numerous within the established range of fisher (0.4 porcupines/km^2), than where fishers were rare (3.5 porcupines/km^2). *The focus is on porcupine populations, not fisher. Little information for management of fishers is presented.*

60. _____, and K.R. Kramm. 1982. Correlation between fisher and porcupine abundance in upper Michigan. Am. Midl. Nat. 107: 244-249.

Michigan, porcupine, predator-prey, re-establishment
1975-1977
see Earle (1978).

61. Edwards, R.Y. 1950. Variations in the fur productivity of northern British Columbia. M.A. Thesis, Univ. of British Columbia, Vancouver. 126pp.

British Columbia, density, distribution, furbearers, habitat, harvests
1929-1948 (harvests)
Yearly harvests of 155 traplines in Northern and Northeast British Columbia were examined with the objective of predicting habitat productivities for furbearers.

Productivity was calculated as the area required to produce 1 pelt in 1 year. Seven forest sections based on physiography and vegetation were designated. Productivities ranged from no fishers in northern mountainous regions and 1 fisher/1727 km² in the Great Plains region of the northeast, to a high of 1 fisher/413 km² in the most southerly eastern forest section. Fishers are trapped in open, largely deciduous forests, and apparently are not as dependent on climax coniferous forests as are marten. Fishers are most successful in drier forests, or in transitional forests bordering dry areas. (*See also MacLeod 1950; Bandy 1952; Edwards and Cowan 1957*).

62. _____, and I. M. Cowan. 1957. Fur production of the boreal forest region of British Columbia. J. Wildl. Manage. 21:257-267.

British Columbia, density, distribution, furbearers, habitat, harvests
1929-1948 (harvests)
A succinct report of Edward's (1950) thesis.

Habitat productivities were calculated as the average area required to produce 1 pelt in 1 year. Seven areas of the Boreal Forest region were designated, the Yukon Forest, the Stikine Forest, the Liard Plain, the Nelson Forest, the Northern Peace Forest, the Peace Parklands, and the Southern Peace Forest. Fisher appeared to be absent from the Yukon and Stikine Forests and became progressively more abundant from north to south on the plains. In British Columbia, fishers are at the northern limit of their range. Productivities of forest areas were South Peace, 455 km²/pelt, Liard Plain 676 km²/pelt, Peace Parklands 858 km²/pelt, North Peace 1170 km²/pelt, and Nelson Forest 1726 km²/pelt. The low productivity value for the Nelson Forest does not support Quick's (1953) designation of it as an area of fisher abundance. Fishers appear to favour areas of relatively dry, well-drained, semi-open mixed forest. The maintenance of fishers in the Peace Parklands may be due to invasion from adjacent regions.

63. Enders, R.K., and O.P. Pearson. 1943. The blastocyst of fisher. Anatomical Record 85(3):285-287.

blastocyst, delayed implantation, reproduction
Confirmation of delayed implantation in fishers.

Six blastocysts were found in the reproductive tracts of 2 fishers, trapped during January and February. A female killed in March had one corpus luteum but no blastocysts.

64. Frank, R., M. van Hove Holdrinet, and P. Suda. 1979. Organochlorine and mercury residues in wild mammals in southern Ontario, Canada, 1973-1974. Bull. of Environ. Contamination and Toxicology 22: 500-507.

environmental contaminants, furbearers, Ontario (southern)
Residues were measured in tissues of commonly occurring omnivorous and carnivorous mammals.

RESULTS: Residues of DDE, TDE, Dieldrin, PCB, and mercury were present in tissues of fishers. *The value of this information is limited without knowing the effects of contaminants on fisher health and biology.*

65. Goldman, E.A. 1935. New American mustelids of the genera *Martes*, *Gulo*, and *Lutra*. Proc. Biol. Soc. of Wash. 48: 175-186.

subspecies, taxonomy

The British Columbia fisher, *Martes pennanti columbiana*, is designated as a new subspecies (95 specimens examined). The locality of the type specimen is Stuart Lake, near the headwaters of the Fraser River. Distribution is the Rocky Mountain region from northern B.C., south to central Idaho, and east, mainly in southern Canada, grading to *M. pennanti pennanti* in Manitoba.

66. Grenfell, W.E., and M. Fasenfast. 1979. Winter food habits of fishers, *Martes pennanti*, in northwestern California. Calif. Fish and Game 65: 186-189.

diets, California
Dec 1977 - Feb 1978

Stomach contents from 8 fishers were identified. Frequently occurring foods were false truffles (4), small mammals (deer mouse, western harvest mouse, broad-handed mole) (4), black-tailed deer (2), gray squirrel (1), brush rabbit (1), and bovine (1). Although no porcupine occurred in stomachs, live captured fishers reportedly had quills in their hides.

67. Grinnell, J., J.S. Dixon, and L.M. Linsdale. 1937. Pages 211-230 *in* Fur-bearing mammals of California: their natural history, systematic status and relations to man. Vol I. Univ. of Calif. Press, Berkeley.

California, density, diets, distribution, habitat use, management, mortality, reproduction, subspecies, taxonomy
An extensive review of the biology of fishers in California.

TAXONOMY: Names of fisher, description, variations in colour, measurements and weights, and a description of the skull are provided. The fisher skull alters with age; the saggital crest increases in size, the zygomatic arches bow outward, and the constriction of the brain case behind the postorbital processes narrows. In a first re-examination, the designation of the race *Martes pennanti pacifica* (Rhoads 1898) is not supported. Much variation occurs in pelt colour. The propensity of fisher to wander permits extensive cross-breeding.

DISTRIBUTION: Fishers occur in the northwestern part of the State, but rarely in the immediate coastal region (redwood belt). They occur at middle elevations, 600-1500 m in the north, and 1200-2400 m in the Mt. Whitney area. Some individuals reach 3270 m in summer. As a rule, however, the fisher in California is an inhabitant of the middle forest belt, at elevations of 1050-2250 m. Seasonal altitudinal shifts occur.

REPRODUCTION: Fisher chose cavities near the tops of large trees, or in hollow logs on the ground, for natal dens. From 2 to 4 young are born, on approximately 1 May. One litter of 3 was found in a den hidden in the crevices of a rock face.

DIETS: From stomach contents and observations, a large part of fisher diet consists of rodents, including porcupines, marmots, mountain beavers, gray squirrels, chickadees, wood rats, chipmunks, and mice. Fishers probably prey on grouse. Occasionally, they resort to vegetable food.

MORTALITY: Two fishers were killed by mountain lions.

DENSITY AND MANAGEMENT: Fisher are nowhere abundant. It is doubtful if densities reach 1 fisher / 260 km^2. The decline in populations is due to their solitary nature and need for large home ranges. Suitable habitats are limited and are being reduced by logging. The commercial value of the pelt and rarity of the fisher make it a desired commodity. Closed seasons and the establishment of refuges are recommended.

68. Guilday, J.E. 1956. Archaeological evidence of the fisher in West Virginia. J. Mammal. 37: 287.

archaeology, distribution, West Virginia
Evidence for historical occupation is uncovered.

Although records are unavailable, historical reports indicate that fishers occurred in the state. Proof is a fisher mandible, dated to 2000 B.C. - 1000 B.C., and found at an Indian site.

69. Hagmeier, E.M. 1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70: 149-168.

Canada, distribution (map), United States
Distributions were determined by a survey of the literature and an examination of museum records. Results are on a state and province basis. Only Canadian distributions and those of adjacent states are summarized here.

The northern limit of fisher is 10° south that of marten. While fishers extend as far south as marten in the Pacific mountains, their range is more restricted in the Rocky Mountains and more extended in the eastern U.S. Fisher are absent from the coastal islands.

ALASKA: no records.
YUKON: occur rarely in southeast Yukon.
BRITISH COLUMBIA: common in forested habitats. It occurs in the following biotic areas:

Coast Forest (MacLeod 1950), Subalpine Forest (Bandy 1952), Cariboo Parklands (Webb 1953), Northern Columbia and dry Forests (east to Alberta) (Bandy 1952), and Boreal Forest (Rand 1944; Edwards 1950; Quick 1953). Fishers do not occur in the Parklands east of Fort Nelson.
WASHINGTON: the Olympic and Coast Mountains, absent in the Puget Lowland, present in Cascade Mountains.
OREGON: the Coast Mountains, and the Blue Mountains of the northeast.
CALIFORNIA: the mountainous parts of the state.
MANITOBA: chiefly between the Ontario border and Lake Winnipegosis, with a few further north along the Churchill River.
ONTARIO: formerly present throughout all of the province except the Hudson Bay lowlands. The southern range is now the French and Mattawa Rivers, and Algonquin Park.
QUEBEC: known only south of a line connecting the southern end of James Bay, Lake Mistassini and Mingan.
ALBERTA: all of forested Alberta.
NORTHWEST TERRITORIES: from Mackenzie District only.
NEW BRUNSWICK: restricted to central and northern parts of province.
MAINE: in all but the southern part of the state.
NOVA SCOTIA: no record of indigenous fisher since 1940. Several were introduced during late 1940's in the southwest part of the province.
NEWFOUNDLAND: no records.
PRINCE EDWARD ISLAND: no records.

70. _____. 1959. A re-evaluation of the subspecies of fisher. Can. Field-Nat. 73: 185-197.

taxonomy, subspecies

Martes pennanti is currently divided into 3 subspecies:
M. p. columbia was designated by Goldman (1935), a British Columbia subspecies; *M. p. pacifica* was designated by Rhoads (1898), a west coast subspecies; *M. p. pennanti* (Erxleben 1777) is an eastern variety, said by Goldman (1935) to occur no further west than the Manitoba - Ontario border.

DATA were 321 fishers captured over 3 seasons (summer, winter, moulting), classified by age class (juvenile, adult), and by sex. Subspecies had approximately equal sample sizes Three external measurements and 14 cranial measurements were taken.

RESULTS: Geographic variation in skull characteristics was slight and the named subspecies are "lightly characterized". Based on the available material, subspecific designations in fisher are unwarranted.

71. Hall, E.R. 1942. Gestation period of the fisher with recommendations for the animal's protection in California. Calif. Fish and Game 28: 143-147.

breeding, British Columbia, California, gestation, litter size, parturition, reproduction, sex ratio
Information on reproduction of fishers on fur farms.

The fisher is rare in California. Despite Dixon's (1925) recommendation, a closed season was not implemented. Fisher have a low reproductive potential, females have one litter per year and litters are small. Fishers are important because they prey effectivly on porcupine. Data were from records of fur farmers in British Columbia (128 - 160 km north of Kamloops). Matings occurred from 5 - 27 April, ($\bar{x}$ = April 12, n = 26), gestation length was 338-358 days ($\bar{x}$ = 352, n = 15), parturition occurred from March 23 to April 7 ($\bar{x}$ = March 31, n = 22). Of 26 litters, the mean was 2.7, range 1 to 4. The sex ratio in 13 litters was 13 males, 20 females. Fisher mated approximately 10 days after giving birth.

72. _____. 1981. Pages 985-987 *in* The mammals of North America. Vol. II. John Wiley and Sons, New York, N.Y. (fisher).

distribution (map), taxonomy

Despite evidence to the contrary, Hall maintains that there are 3 subspecies: Martes pennanti columbiana, Martes pennanti pennanti, and *Martes pennanti pacifica.* See Rhoads 1898; Goldman 1935; Grinnell *et al.* 1937; Hagmeier 1956; Anderson 1970; Youngman 1975.

73. Hamilton, G.T. 1957. Resurgence of the fisher in New Hampshire. Appalachia 31: 485-490.

New Hampshire, popular account, re-establishment

The successful re-establishment of fisher in the state was aided by the fisher's diversity in feeding habits. Fisher may be potential pests to poultry farmers.

74. Hamilton, W.J., Jr., and A.H. Cook. 1955. The biology and management of the fisher in New York. N. Y. Fish and Game J. 2: 13-35.

diets, distribution (map), density, harvests, home ranges, management, morphology, New York, reproduction (techniques), morphology, parasites, pelted:live weight ratio, sex ratios
1949-1953

Reproduction and diets were determined from trapped fishers.

The fisher has increased in the Adirondack Mountains region. Density estimates range from 1 fisher/0.6 km² to 1/10 km². Fishers use home ranges approximately 26 km² in size. Males range more than females. Fishers are active both day and night. Trapped specimens (n = 69) were examined. Harvests were biased to females. Sex-specific harvesting may have contributed to the decline in population size. *Measurements and weights by sex, but not age, were provided.* For 6 fishers (3 M, 3 F), skinned weights averaged 80% of live weights. Diets were estimated using 60 stomach and gastro-intestinal tracts of late fall and early winter fishers. Main foods were deer (carrion, 18%), red squirrel (17%), red-backed vole (17%), shrews (13%), snowshoe hare (13%), porcupine (8%), and deer mice (5%). Birds (grouse, jays) comprised 12%. A technique of syringing uterine horns for blastocysts is described. Endoparasites were identified.

75. Hazard, E.B. 1982. Fisher. Pages 131-133 *in* The mammals of Minnesota. Univ. of Minnesota Press, Minneapolis.

distribution (map), Minnesota, review
Distribution records for the state are provided.

76. Hewitt, C.G. 1921. Chap. IX: The periodic fluctuations of our furbearing animals. Pages 213-234 *in* The conservation of the wildlife of Canada. New York.

furbearers, marten, population cycles, snowshoe hare
One of the first publications describing population cycles in furbearers.

DATA were Hudson Bay Company fur returns 1821-1914. Fisher numbers fluctuate periodically but have a small amplitude, because of low densities. Cycles are regular, with a mean period of 9.7 years. A slight deviation from the 10-year cycle occurred in 1870, probably because of habitat disturbances. Fisher cycles are independent of snowshoe hare cycles, contrary to results for marten. Fishers do not specialize on hares, but have a diverse diet. *See also Cowan 1938; Butler 1953; Bulmer 1974, 1975.*

77. Hodgson, R.G. 1937. Fisher farming. Fur Trade J. of Canada, Toronto. 104pp.

fur farms, reproduction
(Not seen) Results of fisher reproduction from fur farms in Ontario. Cited in many publications including Coulter 1966 and Douglas and Strickland 1987.

78. Hubbard, D.H. 1943. Fisher abroad in daylight. J. Mammal. 24: 268-269.

activity, California
A short account of a fisher observed in daylight.

79. Ingles, L.G. 1965. Fisher. Pages 363, 371-372 *in* Mammals of the Pacific States. Stanford Univ. Press, California.

California, distribution (map), Oregon, reintroduction, review, Washington
A review of fisher distribution and biology.

Fisher are rare in the Pacific States. They occupy the more unsettled areas in forests, lower in elevation than those occupied by marten and wolverine. A map of distribution indicates fisher occupy coastal regions in all 3 states, but primarily in Washington and Oregon. Oregon reintroduced fishers in 1961, for porcupine control.

80. Ingram, R. 1973 (ms). Wolverine, fisher, and marten in central Oregon. Oreg. State Game Commission, Central Region Administrative Rep. No. 73-2. 41pp.

distribution (map), habitat, management, Oregon
Information on wolverine, fisher, and marten in Central Oregon was gathered through literature reviews and trapper interviews.

"Logging and burning of forests have been particularly detrimental to marten and fisher populations. Removal of overstory and ground cover has adversely affected the food supply, cover and denning possibilities...The fisher population is excellent in the Northeastern United States and low in the Western states.". Local trappers indicated that the fisher population in Central Oregon was very low. Management is limited to protection of habitat. Limiting the impacts of logging is a necessity.

81. Irvine, G.W., L.T. Magnus, and B.J. Bradle. 1964. The restocking of fishers in Lakes States forests. Trans. North Am. Wildl. and Nat. Resour. Conf. 29: 307-315.

dispersal, livetrapping, Michigan, movements, porcupine, re-establishment, techniques, Wisconsin

The restoration of fisher in northern Wisconsin.

Fisher vanished in Wisconsin during 1900 - 1920. Contributing factors were logging, burning, and over-harvesting. From 1956 to 1963, 121 fisher (78 M, 41 F) were released in Wisconsin and Michigan forests. Logistics of the transplantation program are discussed (cooperating agencies, livetrapping, holding and shipping, handling and release, legal protection, appraisal of results). Most successful trapping occurred in March. Dispersals from release points were 48 km (21 fishers, no sex/age given), and 64 - 104 km (6 males). About 50% of the other observations have been within 16 km of a release point, and over 90% have been within 48 km.

82. Jenks, J.A., R.T. Bowyer, and A.G. Clark. 1984. Sex and age class determination for fisher using radiographs of canine teeth. J. Wildl. Manage. 48: 626-628.

age determination, Maine, radiographs

The use of measurements from radiographs of canine teeth to separate sex and age-classes of fishers was investigated.

Data were radiographs of 180 lower canines from fishers in New York. Length of canine tooth distinguished sexes. The width ratio (pulp cavity width : total width) was the most reliable for age determination. Four age classes were distinguished, 0, 1, 2 and ≥3 years (*see also Dix and Strickland 1986; Jenks et al. 1986*).

83. ____, A.G. Clark, and R.T. Bowyer. 1986. Sex and age determination for fisher using radiographs of canine teeth: a response. J. Wildl. Manage. 50: 277-278.

age determination, radiographs

The response to Dix and Strickland's criticisms of Jenks *et al.* 1984.

84. Johnson, S.A. 1984. Home range, movements, and habitat use of fishers in Wisconsin. M.Sc. Thesis. Univ. of Wisconsin, Stevens Point. 78pp.

activity, habitat use, home range, movements, Wisconsin (northern)

Aug 1981 - Aug 1982

A one year study using radio-telemetry and tracking. The thesis is presented in 3 manuscripts written for journal submission

HOME RANGES, OVERLAP, AND SELECTION OF ELEVATIONS: Juveniles were considered as 22 months in age and adults, or breeders as > 22 months. Sixteen fishers were trapped (7 M, 9 F). Home ranges were determined for 12 fishers (4 M, 8 F). Male 100% home ranges ranged from 15.2 (68 locations) to 75.2 km^2 (79 locs.), and females from 1.9 (11 locs.)to 14.3 km^2 (193 locs.). Sizes of 100% home ranges may be biased because 32% of locations were obtained during March and April. Breeding movements influenced home range size. Monthly home ranges (February - May, November, December) were determined. Overlap in yearly home ranges was observed between and within sexes. However, monthly home ranges overlapped only for March, in 2 instances involving females. *Although Johnson cautions that the usefulness of results determined from a 1 year field study is limited, he draws broad, unsupported conclusions. Sample sizes are small, especially for monthly analyses, the time frames in which home ranges were calculated are not consistent, and some analyses are broken down by age and others not. Because of the latter, the results section is difficult to follow. Analyses are presented to prove that differences in elevation selection between sexes and seasons existed, however, differences in the mean elevations used by fishers ranged from 3-4 m. Elevations in the study area ranged from 483-533 m. This analysis appears to be unecessary.*

FISHER MOVEMENTS AND TRACK CENSUS: Activity was determined by noting on which locations fishers were active, and by recording activity during the 24 hour day. Two daily activity peaks were recorded, between 0400 - 0759 hours, and 1900 - 2359 hours. Adult males moved more than all other age classes. Little differences occurred between monthly movements of sexes except during the breeding season (March - May). Females raising kits had restricted mobility. Movements were less in January, likely because of cold temperatures and deep snow. *Fisher tracks were also censued, but the objectives ("to evaluate population trends") and methodology were not clear.*

HABITAT USE. Three habitat types were used most often in all seasons, edges, upland northern hardwoods, and mixed swamp conifer - hardwood. Habitats with little or no forest cover were used most often in summer. Monotypic forests with year round forest cover were not used often, probably because of the lack of structural diversity, and lack of prey diversity.

85. Johnson, W.A., and A.W. Todd. 1985. Fisher, *Martes pennanti*, behaviour in proximity to human activity. Can. Field-Nat. 99: 367-369.

activity, Alberta.
Observations of wild fishers (n = 3) near roads and farmlands.

86. Kebbe, C.F. 1961. Return of the fisher. Oreg. State Game Commission, Bull. 16: 3-7.

habitat, Oregon, popular account, reintroduction,

In 1961, 24 fishers from British Columbia were introduced into Oregon. A general discussion of habitat use, reproduction, and hunting behaviour is provided.

87. Kelly, G.M. 1977. Fisher (*Martes pennanti*) biology in the White Mountain National Forest and adjacent areas. Ph.D. Thesis. Univ. of Massachusetts, Amherst. 778pp.

activity, age determination (techniques), blastocysts, densities, diets, forest cover, habitat use, harvests, harvest age ratio, harvest sex ratio, home range, livetrapping, management, measurements, movements, natality, New Hampshire, predator-prey, reproduction, weights

Fishers were followed using radio-telemetry from Oct 1973 to Feb 1976, and carcasses were collected during 1973-74 and 1974-75. Objectives were to determine home ranges, movements, and habitat selection throughout the year; to investigate winter diets; and to develop an aging technique.

HOME RANGES: The study area (113 km²) was in a non-trapped region. Over 3 years, 20 different fishers (6 F, 14 M) were captured. Because of small samples, ages were lumped for analyses. Mean number of corpora lutea in a sample of 12 trapped females (1973-1976) was 3.67. Yearly home ranges were determined for 11 fishers, using a mean number of 25.6 locations (7-70), occurring over a mean of 90.7 days (14-310). Mean adult home ranges were 19.7 ± 17.5 km² (n = 3) for males, and 15.1 ± 3.7 km² (n = 2) for females. Mean juvenile home ranges were 25.6 ± 16.6 km² (n = 3) for males and 15.1 ± 5.9 km² (n = 3) for females. No fishers had an exclusive yearly home range. All sex/age classes overlapped. (Data was unavailable for overlap between adult females). *Kelly reports no differences between age classes and sex, however small samples, variability in size and in the number of days used to calculate ranges preclude making this conclusion.* He states "the yearly home range of a fisher can be estimated by radio locations obtained once or twice a day for seven days during any two week period". *His data do not support this conclusion, and it has been invalidated by others.*

MONTHLY HOME RANGES (n = 24) were determined for 9 individuals (January, May to September), using a mean of 11.0 (5-24) locations collected over a mean of 20.7 (13-30) days. All monthly ranges overlapped among sexes and ages except for the ranges of an adult female and a subadult male during August and September. Movements were greatest for adult males, followed by subadult males. Movements increased during May, possibly influenced by the eruption of deciduous forest cover. A wide river was a barrier to fisher movement, possibly because of difficulty in crossing during summer, and lack of overhead cover during winter. Most locations were obtained between 0700 and 1459 hours. Fishers were active on 74% of locations. Activity increased with the proximity to sunrise and sunset, regardless of the time of year.

HABITAT USE: Fishers used elevations of 329-607 m more than higher elevations. Females used higher elevations (556 ± 82 m) than males (505 ± 121 m). No seasonal differences in use of elevations were noted. Wetland associated forest types (riparian or low lying areas) and mixed softwood-hardwood types were used in greater proportion than available, and hardwood types less, by both sexes. Clearcut forest types (characterized by high stem densities of pioneer species such as cherry, aspen, and paper birch; and crown closures of approximately 100%) were used less than available in winter. These differences were apparent for females only in winter, and only in summer for males. Analysis for habitat selection of males in winter was not possible. Edge habitats were used more than expected in winter by both sexes.

DIETS: Major prey items (>10% frequency) in 30 stomachs were mice, bait, flesh and bone, and sciurids. Porcupine was not found in stomachs but occurred in live fishers and on carcasses (13 of 89); only one was a female. Prey abundance was determined by small mammal trapping. Wetland and softwood-hardwood forest types were above average in small mammal diversity. Hardwood forests had below average diversity. Clearcuts had above average diversity but were used less in winter, likely because of the lack of cover and greater snow depth. Wetland habitats are often associated with and are best created through the activity of beavers. Promotion of beaver colonies would aid fishers.

AGING: The use of cementum annuli as a technique for determining age classes of fishers was examined. Cementum annuli appeared to be deposited in spring, during May or June. The number of annuli corresponded with ages determined using previously established reproductive and morphological criteria.

88. Knox Jones, J., Jr., D.M. Armstrong, R.S. Hoffman, and C. Jones. 1983. Fisher. Pages 277-280 *in* Mammals of the Northern Great Plains. Univ. of Nebraska Press, Lincoln and London.

distribution, North Dakota, review
A generalized account of fisher life history.

Early fur records indicate the fisher was more abundant than the marten in northeastern North Dakota during the early 1800's, but both species were extirpated by excessive trapping and logging. The first new record of a fisher for the state was 1976.

89. Kuehn, D.W. 1985. Calculating whole-body weights of fishers from skinned weights. Wildl. Soc. Bull. 13: 176-177.

Minnesota, morphology, weights
Nov 1982 - Jan 1983
The relationship between skinned and whole weights of fisher was determined.

Data were from 37 males and 14 females. Male fishers had a mean skinned to whole weight ratio of 0.775, and females, 0.811 (significantly different). Ratios did not differ among age classes within sexes.

90. _____, and W.E. Berg. 1979 (ms). Fisher in Minnesota. Pages 118-120 *in* Douglas, C.W., and M.A. Strickland, eds. Trans. of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset Ont., 21-23 Oct 1979.

1977-78, 1978-79
harvest age ratios, diets, fat indices, harvests, Minnesota, natality, trapping seasons, weights
A summary of carcass results and current management.

Trapping for fisher was closed in 1931 and re-opened in 1977. Seasons are 1 Dec - 31 Jan, with a limit of 3 fisher per trapper. Registration of pelts is mandatory. A total of 1218 carcasses over the 2 seasons were examined. Diets were determined from 393 stomachs. Major

prey were snowshoe hare (36% each winter), white-tailed deer (19%, 31%, respectively), and mice (14%, 4%). The increase in deer consumption the second season reflects an increased deer mortality and a decrease in the availability of other foods. Porcupine occurrence was rare. A total of 1159 carcasses were aged and age ratios are presented. Pelted weights averaged 3.5 kg and 2.0 kg, respectively, for adult and juvenile males, and 1.7 kg and 1.6 kg for adult and juvenile females. Body fat indices were greatest for juveniles, and least for adult females. Of all adult females (>1 year), 82% were reproductive, averaging 2.1 corpora lutea.

91. _____, and ____. 1981. Use of radiographs to identify age-classes of fisher. J. Wildl. Manage. 45: 1009-1010.

age determination (techniques), radiographs
The utility of radiographs of fisher canines in distinguishing juveniles from adults was assessed.

Classification of adult or juvenile by degree of pulp cavity closure generally agreed with results using length of saggital crest. Results were verified with cementum analysis. Within the Dec - Jan trapping season, the use of radiographs is a relatively quick and inexpensive method of separating juveniles from adults.

92. Laberee, E.E. 1941. Breeding and reproduction in fur bearing animals. Fur Trade J. of Canada. 166pp.

fur farms, reproduction
(Not seen) Reports of fisher reproduction from fur farms. Cited in many publications including Coulter 1966 and Douglas and Strickland 1987.

93. Leach, D. 1975. The descriptive and comparative post-cranial osteology of marten (*Martes americana* Turton) and fisher (*Martes pennanti* Erxleben). M.Sc. Thesis. Univ. of Guelph, Ont.

See following articles.

94. _____. 1977*a*. The forelimb musculature of marten (*Martes americana* Turton) and fisher (*Martes pennanti* Erxleben). Can. J. Zool. 55: 31-41.

marten, morphology, musculature, Ontario
Nov 1974-Feb 1975
A comparison of the forelimb muscles of marten and fisher and a discussion of their importance for arboreal locomotion.

DATA were 25 fisher (7 male, 18 female), and 25 marten (19 male, 6 female). Both species have a strongly developed forelimb musculature, important in cursorial locomotion. Arboreal locomotion is a secondary function.

95. _____. 1977*b*. The descriptive and comparative post cranial osteology of marten (*Martes americana* Turton) and fisher (*Martes pennanti* Erxleben): the appendicular skeleton. Can. J. Zool. 55: 199-214.

marten, morphology, Ontario, osteology, sex determination
Nov 1973 - Feb 1974
The adult appendicular skeletons of fisher and marten were compared to determine characteristics that may distinguish between species and between sexes.

DATA were 26 fisher (8 M, 18 F), and 25 marten (19 M, 6 F). Inter-sexual differences were greater for fisher than for marten. The skeleton of both species is unspecialized, it resembles that of the domestic cat. However, the forelimb skeletal elements are more developed than in the cat, possibly due to an enhanced digging ability. In fisher, no overlap occurred between sexes in ranges of measurement of the humerus, radius, ulna, tibia, and fibula.

96. _____, and A.I. Dagg. 1976. The morphology of the femur in marten and fisher. Can. J. Zool. 54: 559-565.

marten, morphology, Ontario, osteology, sex determination
Nov 1973-Feb 1974
Characteristics of the femora of marten and fisher are described and characteristics which can be used to distinguish between species and sexes are investigated.

DATA were 142 marten (93 M, 49 F), and 377 fisher (151 M, 226 F). No overlap occurred between species in femur measurements. No structural differences existed between sexes. Although male fishers are larger than females, the femora in both had the same degree of robustness. Overlap precludes using femur measurements to separate sexes.

97. _____, B.K. Hall, and A.I. Dagg. 1982. Aging marten and fisher by development of the suprafabellar tubercle. J. Wildl. Manage. 46: 246-247.

age determination, marten, Ontario, osteology
Nov 1973- Feb 1974
The suprafebellar tubercle is located above the lateral fabellae of the femur.

DATA were femurs of 128 marten and 351 fisher. The percentage of adult and juveniles that did or did not possess a suprafabellar tubercle were determined. The method is reliable for distinguishing juvenile from adult males, in either species, but is not accurate for females.

98. _____, and V.S. de Kleer. 1978. The descriptive and comparative post cranial osteology of marten (*Martes americana* Turton) and fisher (*Martes pennanti* Erxleben): the axial skeleton. Can. J. Zool. 56: 1180-1191.

marten, Ontario, osteology, sex determination
Nov 1974-Feb 1975
The description of the postcranial skeletons of marten and fisher is continued from Leach (1977). Characteristics that distinguish between species and sexes are identified.

DATA were 23 adult fisher (8 M, 15 F), and 25 adult marten (16 M, 9 F). Few structural differences exist between marten and fisher. However, interspecific differences in postcranial skeletal elements are present. Size differences provide more conclusive identification.

Distinction can be made between certain elements of males and females using bone measurements.

99. Leonard, R.D. 1980. Winter activity and movements, winter diet and breeding biology of the fisher (*Martes pennanti*) in southeastern Manitoba. M.Sc. Thesis. Univ. of Manitoba, Winnipeg. 181pp.

activity, breeding behaviour, condition, diets, energetics, fat indices, foraging behaviour, forest cover, habitat use, livetrapping, management, Manitoba, natal dens, natality, radio-telemetry, reproduction, snow cover, tracking

May 1975 - June 1977 (field)
1972-1978 (carcasses)
Objectives were to describe activity, movements, selection of forest cover types during winter, winter diets, and breeding biology.

ACTIVITY: Fewest tracks were observed during January and February. This decrease in mid-winter activity appeared to be related to changes in snow cover. Changes in the use of gaits and cover types were qualitatively correlated with physical variations in snow. Open bogs with a supportive crust were used frequently but avoided during periods of soft snow. Fishers active on soft snow may use an estimated 54% more energy per day than fishers on hard snow.

WINTER DIETS (n = 120 stomachs and gastro-intestinal tracts) consisted primarily of birds (48%), snowshoe hare (36%), small mammals (17%), and sciurids (13%). Only porcupine in diets showed geographic and sex differences. With an increasing density of hares, the proportion in fisher diets increased. This appears to be a functional response by fishers to hare numbers. Use of other prey and the number of different foods also declined as the proportion of hares in the diet increased.

REPRODUCTION of females first occurred at 1 year of age. Estrus and parturition occurred in late March and April. Mean and mode corpora lutea counts for 13 pregnant females were 3.5 and 3, respectively. Testicular volume increased over the winter and all males were spermatic by March. (*See following paper*).

MOVEMENTS of a radio-collared adult female during active pregnancy were not extensive. This female whelped kits (2 seen, likely a total of 4 present) in a tree den. Intensive information on activity and movements from 13 April to 26 May, at den abandonment, were obtained. The female spent more time away from the den with increasing age of kits but did not travel further each day. She maximized the use of her former home range. These data are the first for a fisher female with kits.

100. _____. 1986. Aspects of reproduction of the fisher, *Martes pennanti*, in Manitoba. Can. Field-Nat. 100: 32-44.

litter size, Manitoba, natality, parturition, reproduction
1972-1978
Reproductive characteristics of fishers were determined from carcasses and from observations of fisher movements and behaviour during breeding.

DATA were 195 carcasses from southeast Manitoba submitted from 1972 to 1978, and observations collected using radio-telemetry and tracking during March and April, 1976 and 1977. No juvenile (< 12 months) females had corpora lutea (n = 81). First reproduction occurred at the end of the first year of age. Of 16 adult females, 13 (81%) were pregnant. Most were young individuals (*sample sizes not given*). Mean and mode numbers of corpora lutea were 3.5 and 3. Three females had *in utero* litters of 3 kits each. Estimated dates of parturition, based on embryo development, were late March and early April. On 28 March, a radio-collared female had a litter of 4 kits in captivity, weighing 26.0, 30.0, 30.0, and 30.7 g. She whelped a litter in the wild during early April.

The epididymides of 5 adults and 2 juveniles trapped in March contained sperm. Male movements increased during March. More adult than juvenile male skulls had fractured zygomas, an injury not observed in females. It is hypothesized that during the breeding period, intra-sexual territoriality breaks down as males search for females in estrus.

101. Liskop, K.S., R.M.F.S. Sadleir, and B.P. Saunders. (ms). Reproduction and harvest of fisher (*Martes pennanti* Erxl.) in British Columbia. Simon Fraser Univ., Burnaby, and Ministry of Environ., Victoria. 7pp.

age determination (techniques), British Columbia (Northwest), harvests, natality, reproduction
1976-77 to 1978-79, November to March
The first attempt to quantify productivity of B.C. fishers.

DATA were 60 female and 54 male carcasses provided by trappers in northwest British Columbia. Decay, dessication, and inaccurate labelling of carcasses resulted in a loss of much information. Some females had corpora lutea and blastocyst counts that averaged 2-3 per fisher. A pregnant female trapped in February had 3 embryos (7 mm C.R.). Nine females, 4.5 - 9.5 years in age, had no reproductive activity. A photographic technique for reading cementum lines in slides of sectioned canine teeth is described.

102. MacLeod, C.F. 1950. The productivity and distribution of fur-bearing species of the Coast Forest of British Columbia. M.A. Thesis, Univ. of British Columbia, Vancouver. 105pp.

British Columbia, density, distribution (map), furbearers, habitat, harvests
1929-1948 (harvests)
Yearly harvests of 211 traplines in the Coast Forest Region (north of Howe Sound) were examined with the objective of predicting habitat productivities for furbearers.

Three forest sections were designated. Productivity was calculated as the area required to produce 1 pelt in 1 year. Fishers were rare in the Coast Forest. Productivity was highest in the Inland section (the mainland, Skeena, Nass, Stikine areas), 1 fisher/394 km^2, to a low of 1 fisher/1797 km^2 in the Coastal section (between Douglas Channel and Knight Inlet). Fishers were not reported on coastal islands or on the South Coast (adjacent to Vancouver Island). Fishers are largely confined to the inland sections, and even here, appear to be rare. Results "suggest that this animal is not tolerant of conditions found in the forests of the more humid areas to the west". (*See also Bandy 1952; Edwards 1950; Edwards and Cowan 1957*).

103. Meyer, M., and B.G. Chitwood. 1951. Helminthes from fisher (*Martes p. pennanti*) in Maine. J. Parasitol. 37: 320-321.

Maine (northern), parasites
1950

Of 36 carcasses, 27 had 1 or 2 species of helminthes. Identified species were *Mesocestoides variabilis*, *Ascaris mustelarum*, and *Crenosoma* sp.

104. Monson, R.A., and W.B. Stone. 1976. Canine distemper in wild carnivores of New York.

diseases, New York
Five of 10 fishers from New York were infected with viral canine distemper.

105. Morgan, B.B. 1943. New host records of nematodes from Mustelidae (Carnivora). J. Parasitol. 29: 158-159.

parasites
The nematode *Soboliphyme baturini* was found in the stomach of 1 fisher.

106. Morse, W.B. 1961. The return of the fisher. Am. For. 67(4): 24-26, 47.

Idaho, livetrapping, Montana, Oregon, popular account, reintroduction
A 3-state program to re-establish fisher in the Pacific Northwest is announced.

Fisher were obtained from British Columbia. Montana completed the program in 1960, transplantation is underway in Oregon and Idaho is hoping to begin during 1961-62. Logistics of the Oregon program are discussed.

107. Munro, W.T., and L. Jackson. 1979. Preliminary mustelid management plan for British Columbia. B.C. Ministry of Environ., Fish and Wildl. Branch, Victoria. 16pp.

British Columbia, density, furbearers, harvests, management

British Columbia has 2 management objectives for mustelids: 1) maintain the present diversity, range and population levels, and 2) manage each species in response to harvest demands. Non-hunting recreation is a second priority. The provincial population of fisher is estimated at 10-15,000. Harvests of furbearers and pelt values are included for 1919-20 to 1977-78.

108. Nevers, H.P. 1979 (ms). Harvest characteristics of fisher in New Hampshire (1968-1976). Pages 93-96 *in* Douglas, C.W., and M.A. Strickland, eds. Trans. of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset Ont., 21-23 Oct 1979.

harvest age ratios, harvests, management, natality, New Hampshire, harvest sex ratios, reproduction
A summary of current management and carcass results.

Fisher trapping was reopened in 1961 after 27 years of closure. Harvest records suggest a rapid increase until the late 1960's, followed by a rapid decrease. Submitted carcasses for the 4 seasons 1968 and 1974-1976 totalled 467. Harvest age ratios are presented. Female reproductive tracts were collected during 1973 and 1976. Average number of corpora lutea was 3.67 (n = 12) and 3.41 (n = 17), respectively. No females less than 1 years in age had ovulated.

109. Novak, M., J.A. Baker, M.E. Obbard, and B. Malloch, eds. 1987. Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150pp.

Over 100 authorities present aspects of the biology, trapping and management of North American furbearers. Fishers are discussed with respect to trapping techniques, pelt quality, fur grading, life history, harvests, management, etc. Two chapters are cited in this bibliography, Douglas and Strickland 1987, and Obbard *et al.* 1987.

110. Obbard, M.E., J.G. Jones, R. Newman, A. Booth, A.J. Satterthwaite, and G. Linscombe. 1987. Furbearer harvests in North America. Chapter 64, pages 1007-1034 *in* M.Novak et al., eds. 1987. Wild furbearer management and conservation in North America. Ontario Ministry of Nat. Resour., Toronto. 1150pp.

furbearers, harvests, management
Trends in North American harvests and underlying factors are discussed.

The decline in fisher havests, from the 1840's to the 1940's was due to extensive habitat losses and local extirpations following settlement. The 20th century North America harvest of fishers has been low compared with the harvests of other furbearers, and it appears that factors other than economic ones are responsible. Protective legislation, habitat improvement and reintroductions have restored fisher populations to much of their original range. North American harvests in the 1970's and 1980's have been much higher than peaks observed in 1790's and 1840's. The increase reflects increased demand and high pelt prices, but also appears to indicate an increase in population sizes.

111. Olson, H.F. 1966. Return of a native. Wisconsin Conserv. Bull. 31(3): 22-23.

popular account, re-establishment, Wisconsin
The decline in porcupine populations in Wisconsin and Michigan forests is attributable to the re-establishment of fishers.

112. O'Meara, D.C., D.D. Payne, and J.F. Witter. 1960. Sarcoptes infestation of a fisher. J. Wildl. Manage. 24: 339.

diseases, Maine, parasites
Mites (*Sarcoptes scabei*) caused an extensive scabies infection on an adult male fisher. Porcupine may be a potential transmission agent.

113. Pack, J.C., and J.I. Cromer. 1981. Reintroduction of fisher in West Virginia. Worldwide Furbearer Conf. Proc., Frostburg, Maryland. Vol. II: 1431-1442.

dispersal, habitat, reintroduction, West Virginia

In 1969, 23 fishers (from New Hampshire) were reintroduced into West Virginia. The releases, public reaction, and trapping regulations are discussed. The maximum distance moved was 90 km, and the mean distance 44 km. Most observations occurred in suger maple - beech - yellow birch and red spruce cover types, with no major expansions into oak - hickory habitat. Fisher are currently re-established in the state.

114. Parmalee, P.W. 1958. Evidence of the fisher in central Illinois. J. Mammal. 39: 153.

archaeology, distribution, Illinois, prehistoric distribution

The finding of a prehistoric fisher indicates an original distribution in Illinois more southern than that known from the 1800's.

A mandible and skull section of an adult fisher was found in an archaeological site in the Middle Mississippi. Historic information indicates the southern limit of fisher in Illinois included only the northern section of the state. The find indicates that in prehistoric times, the range of the fisher extended further south.

115. ____. 1960. A prehistoric record of the fisher in Georgia. J. Mammal. 41: 409-410.

archaeology, distribution, Georgia, prehistoric distribution

A first (prehistoric) report of fisher from Georgia indicates a more southerly original range.

A mandible of an adult fisher was found in a refuse pit of an Indian archaeological dig in northwestern Georgia. Original (prehistoric) forests could have provided suitable habitat for fisher. This is a first report from Georgia and represents a more southerly range extension in the southeastern United States.

116. ____, and R.D. Oesch. 1972. Pleistocene and recent faunas from the Brynjulfson Caves, Missouri. Illinois State Mus., Rep. of Investigations, Springfield, Ill. No. 25: 1-52.

distribution, Missouri, porcupine, prehistoric distribution

The occurrence of porcupine and fisher in the same sediments and from the same time period indicate coevolution of these species.

Porcupine and fisher, dated from the late Wisconsin to early postglacial times, were found together in caves. Fisher has been extirpated from the state and no records are available for porcupine.

117. Parsons, G.R., M.K. Brown, and G.B. Will. 1978. Determining the sex of fisher from the lower canine teeth. N. Y. Fish and Game J. 35: 42-44.

New York, sex determination
1975, 25 Oct - 31 Dec
Two tooth measurements, root width and root thickness of the lower canine, are used to estimate age class of fishers.

Data were 247 trapped fishers (98 M, 149 F). Mean root width was 6.44 ± 0.300 mm (range 5.9-7.0) for males, and 4.85 ± 0.298 mm (3.4-5.7) for females. Mean root thickness was 4.80 ± 0.432 mm (3.4-6.0) for males, and 3.58 ± 0.262 mm (3.0 4.7) for females. Using a maximum root width of 5.6 mm (P = 0.955) as a dividing point, 148 of 149 females and all 98 males were sexed correctly. Using a maximum root thickness of 4.0 mm (P = 0.955), 147 of 149 females, and 94 of 98 males were sexed correctly.

118. Penner, D F. 1976. Preliminary baseline investigations of furbearing and ungulate mammals using Lease No. 17. Renewable Resour. Consulting Serv. Ltd., Syncrude Can. Ltd., Environ. Res. Monogr. 1976-3. 156pp. + appendix.

Alberta (Athabasca Tar Sands, north Fort McMurray), furbearers, habitat, track census
1975-76
Baseline information on the winter distribution of furbearers and ungulates was gathered.

Results for marten and fisher were combined in tables but as marten were rare, results primarily apply to fisher. The density of fisher tracks averaged 2.9 x 10^{-2}/track-day. Tracks tended to be frequent in pure white and black spruce cover types and absent in areas of disturbed cover (no observations).

119. Penrod, B. 1976. Fisher in New York. The Conservationist 31(2): 23.

New York, popular account, re-establishment
The announcement of a program to reintroduce fishers into the Catskills and southern New York.

120. Petersen, L.R., M.A. Martin, and C.M. Pils. 1977 (ms). Status of fishers in Wisconsin, 1975. Dep. of Nat. Resour., Res. Rep. 92, 9pp. (Also: Pages 109-117 *in* Douglas, C.W., and M.A. Strickland, eds. 1979. Trans. of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset, Ont., 21-23 October 1979.

distribution, reintroduction (techniques and appraisal), track census, Wisconsin
1974-1976
An assessment of the reintroduction program.

The geographic distribution and relative abundance of fishers were determined. Methods included questionnaires, observations, and expert opinions. After re-stocking, fishers have successfully re-established in the state. An open trapping season is not recommended as suitable range is still unoccupied. Winter track counts may be used as an index to density.

121. Peterson, R.L. 1966. Fisher. Pages 256-259 *in* The mammals of eastern Canada. Oxford Univ. Press, Toronto.

distribution, harvests, Ontario, Quebec, subspecies
A review of fisher distribution in the east.

Peterson maintains that the subspecies *Martes pennanti pennanti* occurs in eastern Canada.

122. Pilgrim, W. 1980. Reports of significant range extensions: fisher, *Martes pennanti* (Carnivora: Mustelidae), in Labrador. Can. Field-Nat. 94: 468.

distribution, Newfoundland
First record of a fisher (1978) for Newfoundland.

123. Pittaway, R.J. 1978. Observations on the behaviour of the fisher (*Martes pennanti*) in Algonquin Park, Ontario. Nat. Can.(Que.) 105: 487-489.

activity, feeding behaviour, Ontario (Algonquin)
3 winters, 1974-1977

Direct observations of fisher behaviour during winter included chasing of a snowshoe hares (n = 2), and eating frozen baits at artificial feeders. Powerful jaw muscles allow fisher to be an efficient scavenger. Peak activity at an artificial feeder occurred at late afternoon and continued through the night to approximately 1 hour after sunrise. Two resting sites, under man-made structures, are described.

124. _____. 1983. Fisher and red fox interactions over food. Ontario Field Biol. 37: 88-90.

feeding behaviour, Ontario (Algonquin)
During December 1979, a fisher displayed dominant behaviour over a red fox at a deer carcass. Both animals were acclimatized to humans.

125. _____. 1984. Fisher, *Martes pennanti*, scent marking behaviour. Can. Field-Nat. 98: 57.

feeding behaviour, Ontario (Algonquin), scent marking
During January 1980, a male fisher was observed marking a deer carcass with urine.

126. Powell, R.A. 1976. Compact carnivore. Anim. Kingdom 78: 12-19.

popular account
An account of fisher biology and an introduction to Powell's Ph.D. studies.

127. _____. 1977. Hunting behaviour, ecological energetics and predatory-prey community stability in the fisher (*Martes pennanti*). Ph.D. Thesis. Univ. of Chicago, Illinois. 132pp.

activity, behaviour, diets, energetics, forest cover, habitat, hunting behaviour, metabolism, Michigan, morphology, optimal foraging, porcupine, predator-prey, resting sites, snowshoe hare, weights
1973-1976

The thesis is the original study for most succeeding papers. Methods included observations of live and captive fishers, snow tracking, and radio telemetry. There are 4 chapters: I. Fisher natural history and general biology, II. A comparison of fisher and weasel hunting behaviour, III. Ecological energetics of fishers during winter and IV. Stability in a one-predator-three-prey community.

I. Morphology, classification, evolution, distribution, reproduction, and behaviour of fisher were reviewed. Behaviour was studied by following tracks. Fishers were also livetrapped and radio collared. Eight were retained in captivity. Fishers were predominantly terrestrial but climbed trees occasionally. Activity was determined using continuous radio monitoring. Fishers were active both day and night and had a small number of activity periods (1-3), lasting 2-5 hours. Of 31 temporary resting sites, 10 were snow dens, 9 hollow logs, 8 holes in the ground, 2 holes in trees, and 1 a hollow stump. One radio-collared female stayed in a rockfall for 3 days.

II. Fisher hunting behaviour was compared to that of weasels. Thirty-three weasel and 33 fisher tracks were followed. Killing behaviour was studied from tracks and observations of captive animals. Weasels foraging for mice and fishers foraging for snowshoe hares changed direction frequently and attempted to flush prey from cover. Fishers foraging for porcupine travelled long distances (up to 5 km), seldom changed direction, and oriented foraging toward porcupine dens. Fishers avoided habitats with no cover. Fishers killed porcupine by attacking the face. Diets were estimated by the analysis of 35 scats. Snowshoe hares, porcupines, white-tailed deer (carrion), and mice were the most frequent prey items.

III. A model for the daily energy budget of fishers was developed and parameters determined from metabolic studies. Oxygen consumption was recorded for fishers running on a treadmill. Active and inactive fishers had metabolic rates slightly higher than the average for all mammals. Estimates of daily energy expenditure for free living, radio-collared fishers ranged from 200 to 450 kcal. An optimal foraging strategy model for fisher was developed. Search time and energy available were the most important factors in determining optimal foraging for a predator with 2 distinct habitats in which to forage.

IV. Five models of fisher predator-prey communities were developed and applied to 1-predator-1-prey and 1-predator-3-prey fisher communities. Stability was investigated using community matrices and simulation. All model communities were stable; 3-prey communities were in general more stable than 1-prey communities. Lack of competition between prey may explain this result. Fisher and porcupine should maintain a stable predator-prey relationship.

128. _____. 1978. A comparison of fisher and weasel hunting behaviour. Carnivore 1(1): 28-34.

diets, hunting behaviour, Michigan, porcupine, snowshoe hare
see Powell 1977, Chapt. II.

129. _____. 1979. Ecological energetics and foraging strategies of the fisher (*Martes pennanti*). J. Anim. Ecol. 48: 195-212.

activity, energetics, Michigan, optimal foraging
see Powell 1977, Chapt. III.

130. _____. 1979. Fishers, population models, and trapping. Wildl. Soc. Bull. 7: 149-154.

management, Michigan, mortality, population models, predator-prey, trapping
A computer simulation of the effects of increased mortality due to trapping on fisher populations (also see Powell 1977, Chapt. IV).

Five predator-prey models were investigated. At equilibrium population levels, the mortality increase causing fisher extinction was equivalent to from less than 1 to 4 additional fisher per 100 km^2. Thus, only small increases in fisher mortality above natural levels may cause local fisher extinction. "Only well established and widespread fisher populations should be trapped". The (present) decline in fisher in northeastern U.S. may also be due to a low in the hare cycle. *Results are quantitatively accurate for the Ottawa National Forest, Michigan.*

131. _____. 1979. Mustelid spacing patterns: variations on a theme by *Mustela*. Zhurnal Tierpsychol. 50: 153-165.

home range, sexual dimorphism, spatial patterns

Spatial patterns and home range sizes of mustelid s are reviewed. Intrasexual territoriality is supported for fisher. There is a strong correlation between the degree of intrasexual territoriality, sexual dimorphism in body size, degree of body elongation, and degree of carnivory. Energy requirements may tie these correlations together.

132. _____. 1980*a*. Stability in a one-predator-three-prey community. Am. Nat. 115: 567-579.

deer, Michigan, porcupine, population models, predator-prey, snowshoe hare
see Powell 1977, Chapt. IV.

133. _____. 1980*b*. Fisher (*Martes pennanti*) arboreal activity. Can. Field-Nat. 94: 90-91.

behaviour, Michigan, movements
1979, January
Movements of a fisher through the tops of trees in a hardwood forest are documented and reports in the literature are reviewed. Arboreal activity of fishers has been exaggerated.

134. _____. 1981. Hunting behaviour and food requirements of the fisher (*Martes pennanti*). Third Worldwide Furbearer Conf. Proc., Frostburg Maryland. Vol II: 883-917.

behaviour, energetics, foraging, habitat, Michigan, porcupine, snowshoe hare
1972-1979

Fisher foraging and killing behaviours were studied during winter in the Ottawa National Forest. Open bogs, muskegs, meadows, pipelines and large logging roads were not used by fishers, snowshoe hare, or porcupine. Fishers always ran across open spaces. Daily energy expenditure of fishers is modelled using activity variables which yield estimates of 200-600 kcal per day. (see also Powell 1977, Chap. III).

135. _____. 1982. The fisher: natural history, ecology, and behaviour. Univ. of Minnesota Press, Minneapolis. 217pp.

A summary of the fisher literature and an extensive coverage of Powell's research. Although the book was written for a general audience, considerable technical information is included. Only major headings cited here.

Chap. 1. THE FISHER. Name, description, classification, evolution, the fisher's ecological niche, study techniques.

Chap. 2. ANATOMY. Post-cranial skeletal and muscular systems; teeth, skull and related musculature; brain.

Chap 3. LIFE HISTORY AND EARLY DEVELOPMENT. Breeding season; male reproductive biology; female reproductive biology; courtship and mating; denning; delayed implantation; neonates and early development; longevity, disease, parasites, and mortality.

Chap. 4. PAST AND PRESENT DISTRIBUTION AND POPULATION DENSITY. Population decline; reintroduction and recovery; population densities.

Chap. 5. GENERAL HABITS, HOME RANGE, AND MOVEMENTS. Home range; habitat; activity and movements; sleeping sites; arboreality; swimming.

Chap. 6. FOOD HABITS. Characteristics of the fisher's diet; the fisher's prey; diet analysis by season and sex.

Chap. 7. HUNTING AND KILLING BEHAVIOUR OF FISHERS HUNTING PREY OTHER THAN PORCUPINES. Hunting behaviour; killing behaviour.

Chap. 8. THE FISHER-PORCUPINE SYSTEM. The porcupine; fishers and porcupine; fishers and quills.

Chap. 9. ECOLOGICAL ENERGETICS OF THE FISHER. Energy acquisition and expenditure; sexual dimorphism in body size and energetics; energy expenditure and reproduction; energetics and foraging strategies.

Chap. 10. CONSERVATION AND THE FISHER'S RELATIONSHIP TO HUMANS. Interactions with humans; the value of the fisher; fishers in captivity; the fisher's future.

136. ____. 1985. Fisher pelt primeness. Wildl. Soc. Bull. 13: 67-70.

Minnesota, New York, Ontario, pelt, primeness, sex ratio
1974-1980

Pelt quality (primeness) of 4,284 fisher (trapped primarily in Ontario) was determined by a fur dealer. The sex ratio of the sample (46 M : 54 F) was significantly different from 1:1. Female pelts brought higher prices and were of "better quality". Primeness peaked in late November or December.

137. ____, and R.B. Brander. 1977. Adaptations of fishers and porcupines to their predator prey system. Pages 45-53 *in* Phillips, R.L., and C. Jonkel, eds. Proc. of the 1975 Predator Symposium. Montana For. and Conserv. Exp. Stn., Univ. of Montana, Missoula.

Michigan, porcupine, predator-prey, prey switching, snowshoe hare
The significance of fisher-porcupine interactions in Michigan was determined. (A significant interaction for porcupine means that porcupine populations are smaller and more stable than without predation by fishers; for fisher, it is better for the energy requirements of fisher to prey on porcupine.)

Fishers were introduced in the study area during 1961-1963. Porcupines were censused in 1961 and each year from 1969 to 1975. The porcupine population declined 76% over 13 years on a 178-ha study area. Both porcupine and fisher are endemic to North America and have a self-regulating predator-prey system. Fisher switch between porcupine and snowshoe hare. Habitat configuration, the placement of food trees in relation to den trees for porcupine, is an important factor affecting the rate of predation.

138. ____, and R.D. Leonard. 1983. Sexual dimorphism and energy expenditure for reproduction in female fisher, *Martes pennanti*. Oikos 40: 166-174.

energetics, lactation, reproduction, sexual dimorphism
A model to estimate energy expenditure of female fishers during lactation was developed. The model is applied to data from an adult female with kits in Manitoba (Leonard 1980).

The non-reproductive energy expended by a 2.64 kg female during early lactation is predicted to be approximately 970 kJ/d when kits are 13-56 days old. Lactation requires 542-1006 kJ/d, approximately 40% of the total energy expended. Other costs increase from 899 to 1330 kJ/d, due to an increase in activity by females when securing food for kits. When kits are 7 weeks old, 2270 kJ/d are required, 2.3 times the needs of a non-reproducing female fisher. Since weaning is incomplete until kits are 10 weeks old, the energy expenditure could reach 2500-2900 kJ/d, almost 3 times the non-reproductive expenditure. The large energy output required for reproduction explains why selection favours smaller size in females. The energy expenditure of females and males is predicted to be the same during reproduction.

139. Pringle, L. 1964. Fisher vs deer. N. Y. Fish and Game J. 11: 67.

deer, diets, New York
An attack by a fisher on a deer fawn is documented.

140. Quick, H.F. 1953*a*. Occurrence of porcupine quills in carnivorous mammals. J. Mammal. 34: 256-259.

British Columbia (Fort Nelson), porcupine
1947-1949

Of 18 fisher carcasses, 5 had porcupine quills. These were found stuck into the stomach, in the flesh over the eye, in the duodenum, in the liver, and in mesenteric fat. Quills do not necessarily result in lethal wounds.

141. _____. 1953*b*. Wolverine, fisher and marten studies in a wilderness region. Trans. North Am. Wildl. and Nat. Resour. Conf. 18: 513-532.

British Columbia (Fort Nelson), density, habitat, harvests, movements, harvest sex ratios, wolverine
A survey of the fur resources of the Fort Nelson region, 1947-1948.

The study area was in the Taiga Biome (spruce forests, white birch, aspen), and subject to intense trapping. Three physiographic subdivisions were recognized: muskeg, foothill and mountain. Density estimates were based on tracking and harvests. Fisher were most numerous in the mountain subdivision. In 1947, 26 fisher and 24 wolverine were harvested. "Populations of fisher and wolverine in Fort Nelson region seemed to be roughly equivalent". Thus, considerable area was not occupied by fisher (*wolverine have home ranges at least 10 times as large as fisher*). Muskeg areas appeared to be rarely frequented. A pre-trapping density (1947) was 1 fisher/208 km^2, or approximately 250 fisher for the region. In 1947, harvest sex ratios were 5 M : 12 F, and in 1948 3 M : 5 F. *In the question period, A. deVos verified findings of others that there is a female bias in fisher harvests.*

142. Raine, R.M. 1981. Winter food habits, responses to snow cover and movements of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba. M.Sc. Thesis. Univ. of Manitoba, Winnipeg. 145pp.

behaviour, diets (winter), foraging, habitat use, home ranges, marten, mortality, Manitoba, movements, resting sites, sinking depth, snow cover
Results of a trailing and radio-telemetry study in boreal forest habitats.
August 1978 - August 1980

Leonard (1980) provided the background for this study. Marten were not present in the study area before 1978 and were an invading population. Relative prey densities (red squirrel, grouse, snowshoe hare) were determined by track counts, small mammal trapping, and scats. Porcupine were rare and muskrats were common. Carrion was available in the form of beaver, moose, and caribou. No deer occurred in the area.

WINTER DIETS: Fisher and marten diets were determined (from 159 and 107 scats, respectively) and compared. Snowshoe hare were at a high in their cycle during the study and constituted the major prey in fisher scats (84%). Other prey were egg (7%), grouse (7%), marten (5%), mice and voles (3%), marmot (2%), and red squirrel (1%). In tracking studies, fishers averaged 1 kill or scavenge (hare, grouse, eggs, squirrel, small mammal) per 5.1 km of trail. Martens displayed more subnivean and arboreal behaviour than did fishers.

HABITAT USE: The physical effect of snow on fisher was examined by recording paces and sinking depth. Tracks were counted and compared to expected if fisher used habitats proportional to availability. All habitats were sampled haphazardly (by "feel"). Api-profiles of snow stations, for the top 10 cm, were determined. Three periods of snow cover were delineated, a) first snowfall, to 20 cm, b) midwinter, <100 g/cm^2, and often <10 g/cm^2, and c) crust conditions, >100 g/cm^2. The change from b) to c) was often abrupt. During the first winter, 65 tracks were observed. More tracks were found than expected on rivers and lakes during a), and more tracks on coniferous ridges during b). During c), habitats were used in proportion to their availability. Fishers used snowshoe hare or their own tracks more often during b). Fishers left long furrows in the snow, often up to 25 cm wide and 10 cm deep. Marten never left furrows. Fishers sank less in snow cover on rivers and lakes than on coniferous ridges. Coniferous ridges were also used by prey species.

HOME RANGES AND MOVEMENTS: Six fishers (2 M, 4 F)and 10 marten were radio-collared; all fishers were juveniles. The midwinter home range of the 2 females was 20.5 km^2 (45 locations in 64 days) and 15.0 km^2 (25 locations in 24 days). Mean distances moved between daily locations were 1.1 km (n = 32) and 2.5 km (n = 18) for the 2 females.

RESTING SITES: Seven subnivean resting dens were observed, 6 in jackpine ridge habitat, and 1 in black spruce bog. Three were under boulders, 3 were under upturned tree roots, and 1 was in the spaces between branches of fallen birch. One den was used sporadically for at least 30 days.

MORTALITY: A young male may have died of starvation. The effects of midwinter snow cover on mortality of fisher are unknown.

143. _____. 1982. Ranges of juvenile fisher, *Martes pennanti*, and marten, *Martes americana*, in southeastern Manitoba. Can. Field-Nat. 96: 431-438.

home range, Manitoba, marten
abstracted from thesis, see Raine 1981

144. _____. 1983. Winter habitat use and responses to snow cover of fisher, *Martes pennanti*, and marten, *Martes americana*, in southeastern Manitoba. Can. J. Zool. 61: 25-34.

habitat use, Manitoba, marten, sinking depth, snow cover
abstracted from thesis, see Raine 1981

145. _____. 1987. Winter food habits and foraging behaviour of fishers, *Martes pennanti*, and martens, *Martes americana*, in southeastern Manitoba. Can. J. Zool. 65: 745-747.

behaviour, diets (winter), foraging, marten, snowshoe hare, tracking
abstracted from thesis, see Raine 1981

146. Rand, A.L. 1944. The status of the fisher, *Martes pennanti* (Erxleben), in Canada. Can. Field-Nat. 58: 77-81.

distribution, Canada, fur farms, habitat, harvests, marten
1920-21 to 1930-31

Provincial distributions and harvests are reviewed.

DATA were fur harvests and pelt values for Canadian fisher. Most fishers were harvested from Ontario and Quebec. None were harvested from Prince Edward Island and Nova Scotia. Harvests in New Brunswick were restricted to the northern third of the province, in Quebec to the southwest third, to 3/4 of Ontario, most of Manitoba except the southwest corner, in Saskatchewan, the northern third, in Alberta, 2/5 of the north and the extreme west, and in 90% of British Columbia. Fishers do not extend as far north as do marten and prefer lower and wetter forest country. In 1912, 2 fisher farms were present in British Columbia, increasing to 23 in 1940.

147. _____. 1944. The recent status of Nova Scotia fur-bearers. Can. Field-Nat. 58: 85-96.

distribution, Nova Scotia
Fishers have been extirpated from the province.

148. Rego, P.W. 1984. Factors influencing harvest levels of fisher in southcentral and southeastern Maine. M.Sc. Thesis. Univ. of Maine, Orono. 54pp.

This thesis was not seen. The only reference was in Douglas and Strickland 1987. They cite 2 results, males had more porcupine quills and fat indices indicated that condition was best in November.

149. Rhoads, S.N. 1898. Contributions to a revision of the North American beavers, otters and fishers. Trans. Am. Phil. Soc., new series, 19: 417-439.

taxonomy, subspecies

Using an "inferior series of skins and skulls", the subspecies *M. canadensis pacifica* is designated (5 skulls, 2 skins examined). (The fisher initially was named *Mustela canadensis* Schreber). Characteristics are a large size, in body and skull. Some colour differences reported. Distribution is the Pacific Slope, from Alaska to California.

150. Rosenzweig, M.L. 1966. Community structure in sympatric Carnivora. J. Mammal. 47: 602-612.

marten, mustelids, predator-prey
A theoretical examination of niche overlap in sympatric carnivores.

Different body sizes allow sympatric mustelids to consume different sizes of prey. Fisher diets consist more of prey in the 50 - 150 g size, and marten diets, 0 - 50 g size. Marten diets are less diverse than diets of fisher. The sympatric coexistence of the 2 species is due to different degrees of specialization.

151. Scheffer, V.B. 1938. Notes on wolverine and fisher in the state of Washington. Murrelet. 19(1-2): 8-10.

distribution, wolverine, Washington, habitat
Observations and trapper records of fisher and wolverine in Washington.

Reports of fisher are concentrated chiefly in the wild and roadless portions of the Olympic Mountains. Fisher have been observed along the Cascade Mountains and as far east as the Okanogan valley. A report of arboreal behaviour is included. One young male was trapped in 1917 at an elevation of 1650 m.

152. Schempf, P.F., and M. White. 1977 (ms). Status of six furbearer populations in the mountains of northern California. U.S. Dep. Agric., For. Serv., Calif. Region. 51pp.

California, distribution (map), elevations, habitat
Observations dated from 1960 were used to determine distribution and habitat use of fishers in northern California.

Fisher in California are most closely associated with mixed conifer and Douglas-fir cover types. In the North Coast Region, 48% of 108 sightings were in Douglas-fir, and 38% in mixed conifer types. In the South Sierra, sightings occurred primarily in mixed conifer types. Fisher were observed in open areas such as clearcuts, grass/sage/juniper, and chaparral habitat types. Fishers use lower elevations than do marten. The North Coast Region currently sustains the densest population of fishers in California. Fishers are rare in the North Sierra and the South Sierra. The "fisher habitat in California is similar to that described in British Columbia by Edwards and Cowan (1957)".

153. Schoonmaker, W.J. 1938. The fisher as a foe of the porcupine in New York State. J. Mammal. 19: 373-374.

New York, porcupine
1926-1932
Accounts of fishers attacking and eating porcupine.

154. Seal, U.S., A.W. Erickson, and J.G. Mayo. 1970. Drug immobilization of the Carnivora. Int. Zoo Yearb. 10: 157-170.

immobilization, techniques
Five fishers in 12 trials were immobilized with 0.7-1.0 mg/kg phencylidine hydrochloride and up to 2 mg/kg promazine.

The addition of promazine hydrochloride reduced side effects seen with the use of phencylidine alone. (*Phencylidine is currently a banned drug*).

155. Seton, E.T. 1926. Vol II, Part II. Order Carnivora or flesh-eaters. Life XXXII: The fisher. Pages 451-479 *in* Lives of game animals.

diets, distribution, habitat, harvests, skull, taxonomy
Seton's seminal studies of life history are well known. Selected results are presented.

HARVEST: During a March sale in Winnipeg in 1904, prime fisher pelts brough $4-$9. During 1906 in London sales, prime pelts brought $12. In 1919-20, the "fur boom", the average price of fisher pelts was $84, with choice pelts bringing $125, and $150. Average prices in the 3 seasons 1920-21 to 1923-24 were $59, $74, and $70. The record price, during 1920, was $345.

HABITAT: The fisher is a forest animal. It seems to prefer swamps, especially among large timber. Natal dens are ofen in hollow trees, 9-12 m off the ground. Dens were also found in logs and rocky crevices. Fishers use habitats similar to raccoon. They frequent damp swampy areas, stagnant pools and shallow lakes where they prey on reptiles, fresh-water molluscs and crustaceans, and small fish. Fishers are often seen swimming rivers and lakes.

DIETS: Fishers are omnivorous, eating berries, beach nuts, and rose-hips. Snowshoe hare are a favourite food. The fisher will steal marten out of traps. It can kill fox, lynx, marten and deer. The dependence on porcupine has been written about as early as 1829. Caching of food is common.

156. Shea, M.E., N.L. Rollins, R.T. Bowyer, and A.G. Clark. 1985. Corpora lutea number as related to fisher age and distribution in Maine. J. Wildl. Manage. 49: 37-40.

harvests, Maine, natality, reproduction
1978-81, October - November
Results of a carcass study.

DATA were reproductive tracts from 355 carcasses. Of 141 pairs of mature ovaries (females ≥1 year in age), 95% had corpora lutea. Corpora lutea were present in ovaries of 93% of 86 1-year-olds and 86% of 22 2-year-olds. All fishers 3 years and older had ovaries with corpora lutea. The mean number of corpora lutea per adult fisher was 3.0 ± sd 1.04, range 0-5. Fishers aged 4-8 years had the greatest number of corpora lutea, a mean of 3.8 ± 0.8. Corpora lutea counts did not differ among 5 ecological regions of Maine.

157. Soper, J.D. 1947. Observations on mammals and birds in the Rocky Mountains of Alberta. Can. Field-Nat. 61: 143-173.

Alberta, distribution
Fishers have apparently been extirpated from most of the region.

158. ____. 1948. Mammal notes from the Grand Prairie Peace River region, Alberta. J. Mammal. 29: 49-64.

Alberta, distribution
Fishers have apparently been extirpated from most of the region.

159. Sprent, J.F.A. 1952. On an *Ascaris* parasite of the fisher and marten, *Ascaris devosi* sp. nov. Proc. Helminthological Soc. of Washington 19: 27-37.

Ontario, parasites
A new species of an ascarid worm was identified from fisher and marten hosts. *Effects on health are not discussed.*

160. Stains, H.J. 1979. Primeness in North American furbearers. Wildl. Soc. Bull. 7: 120-124.

pelts, primeness, United States

Primeness of furs from Alaska and the continental United States was assesed with the assistance of a fur grader. Northern animals become prime earlier and remain prime later in the season than southern animals. Primeness of fisher pelts peaked in January but primeness also included December.

161. Stanwell-Fletcher, J.F., and T.C. Stanwell-Fletcher. 1943. Some accounts of the flora and fauna of the Driftwood Valley Region of Northcentral British Columbia. Occas. Pap. of the B.C. Prov. Mus., No. 4:1-97 (fisher p. 80-81).

British Columbia, distribution
Observations were collected during a reconnaisance.
"Apparently not common". Skulls were obtained from the Sustut River area, the Omineca district, Bear Lake, Driftwood Valley, and Takla Lake.

162. Stevens, C.L. 1968 (ms). The food of fisher in New Hampshire. N. H. Dep. of Fish and Game, Concord. 29pp.

measurements, diets, New Hampshire, parasites
1955-1962, 1965-1967 (3 winters)
A comprehensive, unpublished diet study. Although analyses are lacking, frequency tables itemized by prey species and classified by sex are presented.

DATA were 174 carcasses (72 M, 106 F), submitted by 8 trappers which provided 43 - 61% of the total harvest of the state for the last 2 years of the study. Bait type was known for most specimens. *Although, ages were not determined, most females were apparently juveniles (they had not bred).* For males, 20% of stomachs were empty, and 7% for females. Major prey items (>10% occurrence) for 153 fishers (71 M, 103 F) were fruit (primarily apples), birds, mice and voles, bait, domestic animals, shrews and moles, deer, and hares and rabbits. A second source of data were 337 scats collected between 1955 and 1962. Major prey (yearly diets) were white-tailed deer, snowshoe hare, red squirrel, short-tailed shrew, white-footed mouse, red-backed vole, and birds. *Itemized lists were sorted by sex (for stomachs) and season (for scats) but differences in diets were not investigated. Estimates of prey availability were not provided.*

163. Strickland, M.A., and C.W. Douglas. 1981. The status of the fisher in North America and its management in southern Ontario. Third World Wildl. Furbearer Conf., Proc., Frostburg, Maryland. Vol. II: 1443-1458.

Canada, distribution (map), harvests, harvest age ratios, harvest sex ratios, Ontario, porcupine, reproduction, reintroduction
1972-1980
Indices to trapping intensity are reported.

DATA were more than 1200 carcasses collected from a 13 600 km^2 study area and an additional 1800 from contiguous areas. The fisher population had been reintroduced during 1957-1963 and was being monitored. Times of light and heavy harvests were identified. During periods of overharvest, the ratio of juveniles/adult female (>24 mo) was <4 and the harvest sex ratio was biased to females. During underharvest, the ratio of juveniles/adult females was >4 and the sex ratio was 1:1. It is hypothesized that in a pretrapping population,

the ratio of juveniles/adult females is 2:1 and females outnumber males because of intraspecific strife and mortality between males. In underharvests, juveniles and males are taken above their occurrence in the population, and at a sex ratio of 1:1. In overharvests, juveniles and males occur in the harvest in proportion to their occurrence in the population. Raw numbers of fisher harvested by province and for Canada from 1969-70 to 1978-79 are included.

164. _____, _____, M.K. Brown, and G.R. Parsons. 1982*a*. Determining the age of fisher from cementum annuli of the teeth. N. Y. Fish and Game J. 29: 90-94.

age determination, techniques
The first documentation of a correspondence of cementum lines in teeth with known ages in fishers.

DATA were from 8 known-age fishers (2 M, 6 F). Six were born and raised in captivity and 2 were raised as kits. Tooth sections, mainly premolars, provided 14 age determinations, representing time intervals of 7-53 months. The first cementum annulus, which apparently forms during winter, was discernible at about 15 months. After that, the number of annuli corresponded exactly with the age of the fisher in years from July through March.

165. _____, _____, M. Novak, and N.P. Hunziger. 1982*b*. Fisher. Pages 586-598 *in* Chapman, J.A., and G.A. Feldhamer, eds. Wild mammals of North America: biology, management and economics. Johns Hopkins Univ. Press, Baltimore, Md.

activity, age ratios, age determination, behaviour, breeding, density, description, distribution, diets, gestation, habitat, harvests, harvest sex ratios, home range, litter size, management, morphology, mortality, natal dens, parasites, parturition, reproduction, resting sites, review

An extensive literature review of fisher biology and management. A more recent and detailed version is Douglas and Strickland 1987.

166. Thomasma, L.E. 1988. A test of the habitat suitability index model for the fisher (*Martes pennanti*) in the Upper Peninsula of Michigan. M.Sc. Thesis. Mich. Tech. Univ., Houghton. 24pp.

habitat suitability index (HSI), management, Michigan, track census
1985-86, 1986-87
The first (publicized) verification of Allen's (1983) HSI model.

The study area was in the Ottawa National Forest (the location of R.A. Powell's research). The fisher is protected in Michigan and the study population was unharvested. Habitat use during winter was determined by quantifying habitats at fisher tracks, along systematic transects. HSI's were determined using 2 methods, plot measurements of habitat variables and remote sensing coupled with U.S. Forest Service maps. The model was not falsified with the plot data but was with the Forest Service data. Fishers used habitats with high HSI values more frequently than expected and fisher habitat preference was positively correlated with HSI values. However, the predicted HSI values within pine plantations were higher than what fisher used.

167. Toner, G.C. 1946. Notes on the mammals of the lower Chilcotin River Region, Cariboo District, B. C. Can. Field-Nat. 60: 86-89.

British Columbia, distribution
Fishers are rare; 1-2 are taken each year by trappers.

168. Wallace, K., and R. Henry. 1985. Return of a Catskill native. The Conservationist (New York) 40(3): 16-19.

New York, popular account, reintroduction
Fishers were reintroduced into the Catskills (n = 43) from 1976-1979 and have re-occupied most of what was considered potential habitat.

169. Weckworth, R.P., and P.L. Wright. 1968. Results of transplanting fishers in Montana. J. Wildl. Manage. 32: 977-980.

dispersal, movements, Montana, reintroduction

During 1959-60, 36 (16 M, 20 F) fishers from British Columbia were released in western Montana. Females trapped the following year were reproducing normally. Females were recovered 55-56 km from release points. Two males travelled at least 72 and 102 km.

170. Wharton, D. 1983. The fisher returns. Am. For. 89(9): 36-37, 48-49.

popular account, United States.
A summary of the decline and re-establishment of fishers.

171. Williams, R.M. 1962. The fisher returns to Idaho. Id. Wildl. Rev. 15(1): 8-9.

Idaho, reintroduction
The first phase of a reintroduction of fishers is documented. Decline of fishers in the state may have been due to overtrapping, non-selective predator control, and reduction of habitats due to settlement, logging and fires.

172. Wood, J. 1977. The fisher is ... Natl. Wildl. 15(3): 18-21.

popular account, reintroductions, United States

The fisher has been condemned as a killer of pets and livestock. The reintroduction programs in New York, Vermont, West Virginia, Wisconsin, and Michigan are discussed. In most states, fisher are increasing in numbers but in New Hampshire, populations are declining. The availability of dead deer during fall and winter as carrion contribute to the health and geographic spread of fishers (pers. comm. R. Fuller, Vermont biologist).

173. Wright, P.L., and M.L. Coulter. 1967. Reproduction and growth in Maine fishers. J. Wildl. Manage. 31: 70-87.

age determination, Maine, natality, parturition, reproduction, skull, weights
1950-1964, October - April

Results of a carcass study originating in Coulter 1966.

DATA were from 204 carcasses. All females greater than 1 year in age were pregnant. Adult females trapped in January, February, and March (n = 9) had implanted embryos. Parturition is estimated to mostly occur in March but may range from February to April. Counts of corpora lutea (n = 44 females) averaged 3.28. Females bred for the first time at 1 year of age. Juvenile females were distinguished from adults by open sutures in the skull during the first year of age. Juvenile males were recognized in early fall by open sutures in the skull, no saggital crest, lighter weight of bacula, and unfused epiphyses. The saggital crest begins development in December and often is well developed by March. By February, overlap in weights of bacula occurred between juveniles and adults. Males showed active spermatogenesis at 1 year. Carcasses averaged 0.819 of whole weights (*see also Coulter 1966*).

174. Yocum, C.F., and M.T. McCollum. 1973. Status of the fisher in Northern California, Oregon and Washington. Calif. Fish and Game 59: 305-309.

California, Oregon, Washington, distribution

Records of fisher observed or trapped in these states are presented. Fisher occur in northwestern California, records for Oregon are primarily in the southwest, and in the west (but not on the coast) in Washington.

175. Youngman, P.M. 1975. Fisher. Pages 142-143 *in* Mammals of the Yukon Territory. Natl. Mus. of Can., Ottawa.

distribution (map), Yukon

Fishers occur only from the southeast corner of Yukon. The author agrees with Hagmeier (1959), that observed differences do not warrant a subspecific designation for *Martes pennanti columbia*. The present distribution and ecology of the fisher suggests that it is a postglacial immigrant to Yukon.

3.3. SUBJECT INDEX

Publications are referred to by their identifying numbers (located on the first line and to the left of each citation).

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